CLINICAL APPLICATIONS
OF
DIAGNOSTIC AND THERAPEUTIC
NERVE BLOCKS

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Clinical Applications Of Diagnostic And Therapeutic Nerve Blocks

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This Book is Dedicated to

My Mother

Angela Zagame Bonica

and

My late Father

Antonino Bonica

In appreciation for their love and many sacrifices and for forsaking traditions and wealth so that I might escape the effects of dictatorship and have the opportunities in America which have made this and other writings possible

PREFACE

In recent years there has been a remarkable increase in the interest in and use of nerve block technics as diagnostic, prognostic, prophylactic and therapeutic tools outside the operating room This trend has been due to a number of factors, including the following the advent of more effective local anesthetic drugs and marked improvements in certain technics, developments of methods of ascertaining the degree of block, a better appreciation of the indications and limitations, as well as of the complications of these technics when used for diagnostic and therapeutic purposes, and coordinated laboratory and clinical studies concerning various aspects of this method Numerous reports containing evaluations of various diagnostic and therapeutic nerve blocks (1-32) and several monographs (33 48) and a major reference work (49) on the subject have tended further to stimulate interest in this method

Despite these developments, there are still serious misconceptions among some clinicians concerning the usefulness and role of these technics These are conspicuously apparent upon a perusal of the literature, which contains conflicting reports and an obvious lack of unanimity of opinion regarding the value of this method some articles are obviously over-enthusiastic while others suggest that this method is of little value To help rectify the situation the Committee on Post-

though the anesthesiologist, having acquired a certain dexterity in executing nerve blocks for surgical anesthesia, is most frequently requested to perform these procedures on medical patients, the use of this method should not be considered the exclusive domain of any specialist Many of these procedures can and should be learned and practiced by every clinician

Limitations imposed by the scope and size of the volume have prohibited detailed description of technics The approach preferred under certain circumstances is indicated and some illustrations of these technics have been included For a detailed description of nerve block technics, the reader may consult the book of Moore (29, 47), Pitkin (44), Bonica (49), Adriani (50) and Macintosh (51-54) For the same reason a detailed discussion of the disorders for which these procedures may be used has been omitted Moreover the bibliography has been limited to the most important reference works These and other aspects of the subject are presented in great detail in my other book, "The Management of Pain" which also contains a very extensive bibliography Lest the reader obtain the wrong impression that this is an abbreviated form of the large volume already published, let me hastily add that the material herein presented is treated from an entirely different angle and contains information which has become available since the larger work was published

It is a pleasure to acknowledge the suggestions and encouragement of Dr Daniel C Moore, Director of Anesthesiology at Mason Clinic, and Dr D F A Alexander with whom the author has spent many pleasant hours in discussions, from which many of the concepts contained herein have evolved I would also

graduate Education of the American Society of Anesthesiologists has offered in the past a refresher course dealing with the subject It was at the end of one of these sessions that my close friend, Dr Daniel C Moore, suggested to me and subsequently to Doctor Adriani that I expand the material into a small monograph In view of the aforementioned literature, books dealing with specific technics and the reference work already available, I dismissed the idea at first However, after serious consideration I agreed with Doctors Moore and Adriani that a brief, concise monograph would fill the definite need which presently exists and is felt particularly by the busy clinician

With this in mind, I have attempted to present the subject in such a manner in the hope that I may en courage even the busiest of practitioners to become acquainted with it and consequently to use it to the advantage of the patient The aim of the book, then, is to present an evaluation of various nerve block pro cedures as diagnostic and therapeutic tools A serious attempt has been made to present an objective assess ment of the indications, effectiveness, advantages, as well as the disadvantages, complications and limitations of these technics The chapters in the first section will be devoted to certain general considerations concerning the clinical applications of nerve blocks in the management of disease This material will form the basis for a discussion of the use of specific nerve block technics It is advisable that the novice who plans to employ these procedures have a thorough knowledge of the material contained in these six chapters before he attempts to carry out the blocks

It should be stressed that the book is intended for use by any practitioner interested in this problem Al

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like to express my appreciation to Dr Steven J Martin, Director of Anesthesiology, St Francis Hospital, Hartford, Connecticut, who for many years was Chairman of the Committee on Postgraduate Education of the American Society of Anesthesiologists, and also to the members of his various committees for having afforded me the opportunity and privilege of presenting the aforementioned course

I am also most pleased to acknowledge my appreciation to my secretaries, Mrs Dorothy Richmond, Mrs Rosemary Gottlieb, and Mrs Elizabeth Rando for the inestimable aid they have given me in the preparation of this manuscript My thanks are also due Doctors Charles E Glaser, Kiyoaky Hori and Thomas Ziegler for aiding in reading proof

I am again prompted to acknowledge the great contributions of my wife, Emma Louise, for her assistance in the preparation of the manuscript as well as for the encouragement, tolerance and patience which she and our children have manifested during this and other writings

I wish to express my heartfelt thanks to Lea and Febiger, Publishers, particularly to Mr John Spahr for his courtesy and cooperation in making available plates for many of the illustrations found in this volume Finally, I would like to express my appreciation to the staff of Charles C Thomas, Publisher, for their valuable help and considerations

JOHN J BONICA

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CLINICAL APPLICATIONS OF DIAGNOSTIC AND THERAPEUTIC NERVE BLOCKS

PART 1

BASIC CONSIDERATIONS

CHAPTER I

HISTORY*

THE USE OF LOCAL and regional injection of various compounds for the management of medical disorders dates back many centuries Acupuncture for the treatment of various diseases was practiced in China as early as 3,000 B C , and the use of this method has continued throughout the centuries, particularly in that country where it is still being employed During the 17th century, Sigmund Elsholm and several others attempted to inject opiate in the vicinity of nerves and painful areas in order to relieve pain This method was employed until the latter part of the last century, but particularly after 1855 when Wood of Edinburgh popularized the use of the hollow needle, which had been described ten years earlier by Rynd of Dublin, and the use of the glass syringe, which had been devised a few years earlier by Pravaz of France

The introduction of the syringe and needle into clinical practice can be considered a milestone in the annals of medicine From that time on many efforts were made to treat disorders by injecting solution of opiates, chloroform, bromides, tannin, and other com-

*In order to keep the number of references within reasonable limits only the most important will be cited directly The others can be found in writings of Bonica (49) Matas (55) Braun (56) Pfender (57) Bumpus (58) Ruth (59) and Keyes (60)

technics for treatment of various disorders about the head and neck

The reports of beneficial results obtained in the treatment of neuralgia led other clinicians to employ alcohol nerve block for the management of other conditions In 1911, Lewy and subsequently Fetterwolf reported beneficial results in the injection of the superior laryngeal nerve with alcohol in patients with intractable pain due to advanced tuberculosis This technic was later employed by Lukens, Swetlow, and others as a useful means of managing various disorders of the larynx, including intractable cancer pain

One of the most brilliant chapters in the history of the use of nerve blocks for nonsurgical patients concerns the application of paravertebral block as an aid in differential diagnosis of various abdominal diseases Although this technic for surgery had been suggested by Sellheim as early as 1905, and subsequently employed for operations by Lawen, Von Gaza Nieman, Kappis and Finsterer, it was not until 1922 that Lawen, and Freude and Kanvellis proposed its use for medical patients A year later, Kappis and subsequently Von Gaza and Brunn and Mandl employed it as a diagnostic and therapeutic measure in visceral pain In 1926, Mandl gave an account of its use, especially in the treatment of angina pectoris, and a year later he published a monograph on paravertebral block and its use in diagnosis, prognosis, and therapy of disease (63) Subsequently this technic was widely used by Mandl, Leriche, White, Woodbridge, Ruth, Livinstone, and others as a diagnostic-prognostic tool in determining the pathways of obscure visceral pain

Another important milestone in the clinical application of diagnostic and therapeutic nerve blocks was

pounds near nerve trunks In 1874 Bartholow reported good results in treatment of trigeminal neuralgia, and subsequently Billroth and Neuber proposed the injection of osmic acid into main branches of the 5th cranial nerve for the management of the same condition Fauvel, Collin, Taglia and others employed cocaine topically to relieve painful conditions of the pharynx and larynx

Thus many recorded attempts were made at nerve block therapy, but for obvious reasons these trials failed until Karl Koller almost four decades after the invention of the syringe and needle reported the clinical use of cocaine for anesthesia (61) Immediately following Koller's report, the injection of cocaine into tissues near nerves or into the nerves themselves was practiced by many clinicians Outstanding among these was Halstead, who was the first to recognize and employ the principle of nerve blocking Another was J Leonard Corning, a New York neurologist, who was the first to attempt to produce spinal anesthesia, first in dogs and subsequently in a man, for treatment of "spinal weakness and seminal incontinence" and many other neurologic disorders The next most important developments in the clinical application of nerve block were the synthesis and introduction of Novocaine (procaine) into clinical practice in 1905 by Einhorn (62)

At about this same time Schlosser began experimenting with the injection of alcohol into the nerves of the face for the treatment of tic douloureux In 1902, Pitres and Verger of France also reported their findings with this procedure, and a few years later similar reports were made by Ostwold, Levy and Boudouin, Offerhaus, Hecht, Keller, Wright, Harris, and particularly Hartel, who did much pioneer work to refine nerve block

companying a variety of disorders, but particularly for that associated with cancer

The next important milestone in this field was the description by Lemmon in 1940 of the continuous spinal technic (67) Four years later, Touhy described a modification of this technic involving the insertion through a large spinal needle of a small ureteral catheter which was left in place after the needle was removed (68) Subsequently, other modifications of this technic were described Moreover, the principle was applied to caudal analgesia by Southworth and Hingson

Although this means of prolonging the effect of local anesthetic drugs for several hours was originally devised to produce surgical anesthesia, the advent of muscle relaxants has caused it to assume a place of secondary importance in such anesthesia This method, however, came to be used with many regional anesthetic technics in the therapy of different medical disorders In this connection particular mention should be made of the work of Sarnoff and Arrowood, who devised the refined technic "differential spinal block" which is the subarachnoid injection of dilute solutions of local anesthetic drugs used only for diagnosis and therapy Subsequently, this principle of repeated injections made through indwelling catheter or plastic tubing has been adapted to spinal epidural block, paravertebral block, cervicothoracic sympathetic block, sciatic nerve block and brachial plexus block

During the past decade many reports have appeared describing the application of these and other technics as diagnostic and therapeutic tools in the management of many disorders Although the results reported are not entirely in accord, and some are even contradictory,

erected in 1926 when Swetlow described the use of alcohol to secure a lasting interruption of all the cardiosensory nerves in the treatment of angina pectoris (64) Swetlow's report prompted many other clinicians, but particularly J C White and his associates and Labat, to employ this technic for this purpose with brilliant results Moreover, the use of paravertebral alcohol block was extended by Swetlow and others for the management of severe intractable pain in many other conditions, particularly cancer In 1930 Leriche first reported the use of paravertebral sympathetic nerve block for the relief of the intense pain associated with posttraumatic reflex sympathetic dystrophies, a method which was subsequently employed widely by Homans, Livingstone, White, DeTakats, Ochsner and DeBakey, and many others

In 1931, two very significant developments were made by Dogliotti which were to prove of inestimable value as diagnostic and therapeutic tools One was the description of the technic of spinal epidural block (65), a procedure which had been proposed ten years earlier by Fidel Pages, a Spanish military surgeon, which he had called metameric anesthesia Doctor Dogliotti's writings on the subject popularized this technic, especially in Europe and South America, and subsequently it became employed rather widely, not only for surgical anesthesia, but also in the diagnosis and therapy of many medical disorders The other development was the description of the technic of subarachnoid alcohol block, which Dogliotti advocated for the relief of intractable pain (66) His report prompted many clinicians, including Stern, Saltzstein, Greenhill, Russell, Abbott, and Poppen, to employ this method for the relief of the persistent pain ac-

CHAPTER II

BASIS FOR THE USE OF DIAGNOSTIC AND THERAPEUTIC NERVE BLOCKS

THE EFFECTIVENESS and utility of nerve blocks as diagnostic, prognostic, prophylactic, and therapeutic measures in the management of various diseases are dependent upon their inherent property of interrupting specific sensory, somatic motor, and autonomic pathways Sensory blockade effects relief of pain and of other abnormal sensory phenomena such as paresthesia, it interrupts the afferent limb of abnormal reflex mechanisms, and it segregates or isolates an abnormal peripheral focus of stimulation which may be initiating noxious impulses The somatic motor blockade effects relief of skeletal muscle spasm, and the block of the autonomic pathways, particularly of sympathetic nerves, relieves the abnormal autonomic activity produced by diseased states By producing one or more of these effects the physician may be able not only to provide relief from discomfort but also to correct the physiopathologic state and thus reestablish normalcy The latter is brought about by an almost enigmatic phenomenon — the fact that the beneficial effects outlast by hours, days, and sometimes weeks

they do indicate the widespread use of this method and make it obvious that this phase of medical practice, though still in its developing stage, has captured the imagination and interest of many clinicians It is hoped that this volume will help to place this method in its proper perspective so that it will be properly applied and thus provide patients with maximum benefit

receptor end organs which are frequently referred to simply as receptors and may be considered as accessory structures of these neurons The central branch of the receptor neuron proceeds to enter the neuraxis (spinal cord or brain stem) by way of the sensory roots of spinal and cranial nerves, respectively, and there to synapse with the connector or internuncial neuron

The correlator neurons, frequently called internuncial or connector, or intercalated neurons, make connections with ascending and descending fibers in the spinal cord and with its dorsal, ventral, and lateral horns as well as with the centripetal branches of the receptor neurons Their function is to receive impulses from the receptor neurons and to carry them to the higher centers of the brain and, equally important, to bring about the correlation of impulses coming from the periphery and from various parts of the central nervous system These structures then act as receiving stations and determine the routing of sensory impulses and the dispersal of motor impulses to the periphery They accomplish this function in two ways Either they facilitate sensory impulses by arranging for the convergence of internuncial impulses with those coming from the sensory end organ, or they inhibit any sensory, autonomic, or skeletal motor impulse by creating a condition of subnormality at the synapse In other words these neurons, which are also frequently collectively referred to as the internuncial pool, are constantly active in sorting out incoming impulses to facilitate or inhibit them and to switch them into the proper channel where again they may be either facilitated or inhibited in producing autonomic or somatic motor effects Usually the status of the activity of the internuncial pool is such as to insure that the sensations

the transient physicochemical interruption of nerve impulses

In order to fully comprehend this phenomenon and to properly apply diagnostic and therapeutic nerve blocks, it is essential to understand the mechanism by which relief is brought about Such an understanding will permit the physician to make a better selection of patients and to select the best site for interruption, and it will give him a better insight into the entire problem so that he can apply not only this method but other forms of treatment for the optimal benefit of the patient To obtain such an understanding, it is necessary to consider the subject under four headings (1) Normal neurophysiology, (2) Neurophysiopathology or disturbances in the nervous system brought about by noxious stimulation, (3) The pain process, and (4) A summary of the three headings above with special emphasis on the mechanism of reversal by nerve blocks

Neurophysiology

The primary function of the nervous system is to integrate and correlate the actions of various parts of the body to maintain the organism in homeostasis This very important function is made possible by the special arrangement in polarity of various neuron elements, which may be classified functionally into three fundamental categories (1) receptors, (2) correlators, and (3) effectors The receptor or afferent neurons have their nerve cells in the ganglia of the spinal and cranial nerves and their axons divide into peripheral and central branches The peripheral branches are distributed to various structures of the body and end either as bare or amyelinated fibers or in

volving the cerebral cortex, manifested by the phenomenology of pain sensation and complex psychologic and physiologic responses, i e , the reaction patterns characteristic of the pain process or pain experience It should be noted that although these reactions are associated with the sensation of pain in conscious man, local and segmental responses can also occur in the anesthetized or unconscious man although he is precluded from the sensation and experience of pain

The degree, magnitude and duration of these responses is dependent upon the intensity, site, and duration of the stimulation, and on the condition of the central nervous system particularly that of the internuncial pool and cerebrum The more intense the stimulus, the greater the response, other conditions being equal Noxious stimulation of certain parts of the body such as the digits of the extremities, which are richly supplied with sensory nerves, or direct stimulation of the sensory nerves is likely to produce a greater response than noxious stimulation of other areas of the body, the viscera for example, which have a significantly smaller number of sensory nerves Perhaps the most important of all the three factors is the duration of the noxious stimulation brief stimulation, even of an intense degree, produces considerably less reactions that a prolonged stimulus, even if the latter is of moderate intensity As the stimulus is eliminated and healing progresses pain subsides and disappears, circulatory homeostasis reappears and the functions of other organs are restored

Neurophysiopathology

In some instances there is a persistent chaotic response especially if the stimulation is persistent

which register into consciousness and the patterns of motor response will be normal

The effectors or efferent conductors convey impulses, which are the result of correlation, from the central nervous system to an effector organ, muscles, glands, and hair follicles

External or internal agencies that are deleterious to the organism, such as accidental, surgical, or occupational trauma, visceral or neurologic or vascular disease, infections, musculoskeletal disorders, or other changes that might be brought about by disease states, produce noxious stimulation which excites nerve endings These in turn set up impulses that provoke typical patterns of response or reactions which contribute to the process of adaptation and reestablishment of homeostasis Depending upon several factors, the type of response may be one or more of the following (69)

(1) Local tissue reaction at the site of stimulation, manifested by signs of inflammation, local tenderness, and the presence of local excitatory state,

(2) Reactions at segmental levels of integration including neural structures up to the mesencephalon, manifested by spasm of skeletal and smooth muscles and by glandular hyperactivity, i e , patterns exhibiting automatic withdrawal, blushing, sweating, bladder and bowel emptying etc ,

(3) Reactions at suprasegmental levels, including the mesencephalon, basal ganglia, hypothalamus, thalamus, and parts of the cerebral cortex, manifested by more highly integrated but still automatic protective and adaptive patterns, including respiratory and cardio vascular reactions and quasipurposive movements,

(4) Reactions at the highest integrative levels in-

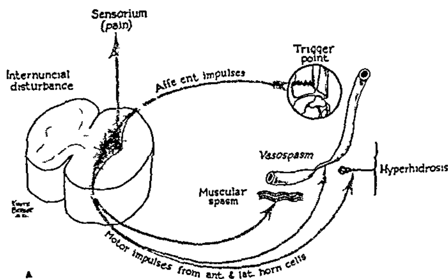


FIGURE 1 A schematic diagram to depict the physiopathologic mechanism of the vicious circle of disease (A) Shows the early stages of disturbance initiated by a fracture The afferent impulses from this trigger point reach the spinal cord wherein

(Continued on next page)

Chronic stimulation, be it due to injury, disease, or infection, serves as a focus of chronic irritation from which an abnormal number of impulses arise and constantly bombard the spinal cord (70). These impulses upset the normal function of the internuncial pool and may even permanently damage its integrating mechanism. The resultant abnormal activity of the internuncial neurons spreads upwards, downwards, and across to implicate other neuron systems and the anterior and lateral horn cells and to produce excessive skeletal and smooth muscle activity. Consequently there is skeletal muscle spasm, vasospasm, and glandular and visceral disturbances which produce hypoxemia, hypercarbia, and metabolites that serve to stimulate sensory nerve endings abnormally and in this way furnish new sources of pain and reflexes. These in turn aggravate the central disturbance in the cord and set up the so-called vicious circle. Finally, as the intensity of this self-sustaining process is increased, more and more neuron systems are drawn into it, as depicted in Figure 1.

It is important to reemphasize that the irritable focus may result not only from external trauma, but from various visceral disease states, as for example, myocardial infarction, from infection, or from any structural disorder. Moreover, strong impulses from the high centers in the brain may likewise influence the spinal cord disturbance to set up the same type of vicious circle with the aid of some minor stimulus in the viscero-somatic system, which in itself would be insufficient to produce a vicious circle. A vicious circle of nerve impulses, which originates from an initial insult to visceral or somatic structures and sets in motion a chain of events that later has no further

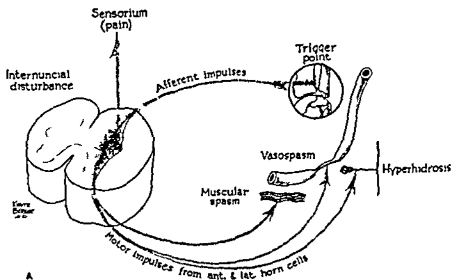


FIGURE 1 A schematic diagram to depict the physiopathologic mechanism of the vicious circle of disease (A) Shows the early stages of disturbance initiated by a fracture The afferent impulses from this trigger point reach the spinal cord wherein

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dependence on the afferent impulses from the initial structure stimulated, is made possible by the sustained facilitation of the noxious impulses by the closed self-reexciting chains of the internuncial neurons (70)

A further comment concerning skeletal muscle spasm as a result of noxious stimulation Noxious stimulation of almost any structure of the body is frequently accompanied by contraction of skeletal muscles The reflex muscle spasm of abdominal visceral disease is perhaps the best known It is now being appreciated that myocardial infarction is often accompanied by reflex spasm of chest muscles Noxious stimulation of any superficial or deep somatic structure such as muscles, tendons, ligaments, fascia, or bones, is often accompanied by reflex muscle spasm as well as by the other reflex reactions previously mentioned If the stimulus is short lived these effects are also brief If, on the other hand, the noxious stimulation is intense or persists, local sustained contraction of adjacent muscles takes place and such effects may spread to involve more distant regions Prolonged skeletal muscle spasm, vasospasm, and other changes in various body functions brought about by the physiologic response to noxious stimulation frequently act as new sources of noxious stimulation and initiate and/or perpetuate the aforementioned vicious circle In this manner, pain

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they set up disturbances of the internuncial pool This results in increase activity of anterior and lateral horn cells which in turn produces increased motor activity of the affected segment The consequent vascular spasm and skeletal muscular spasm become new sources of noxious stimulation which initiates more afferent impulses (B) Depicts the fully established vicious circle with expansion of the internuncial disturbances and consequent involvement of other segments such as occurs in causalgia and other reflex dystrophies

produced by the secondary source may long out-last the original noxious stimulation

Prolonged noxious stimulation from the viscera, although not painful in itself, may also induce reflex skeletal muscle spasm which may provide a further new source of noxious stimulation and pain For example, sustained distention of the urethra may be accompanied by reflex skeletal muscle spasm which may be of such a degree as to become a major factor in the patient's discomfort for as long as twenty four hours after the cessation of the stimulation (69) Noxious stimulation of the eye (foreign body, instrumentation, etc), or of the mucous membrane of the nose and paranasal sinuses, or of the teeth or of other sensory structures around the head frequently causes contraction of adjacent and remote muscles, such as the frontal, temporal, occipital, and cervical muscles (73) Associated with this reflex reaction, there may be autonomic disturbances in the form of vasoconstriction and consequent ischemia, lacrimation, nasal congestion, edema of the eyelids, reddening of the conjunctiva, photophobia, sweating, nausea, and vomiting Thus it is apparent that noxious stimulation, whether involving somatic or visceral structures, gives rise to the same type of reflex muscle spasm, which becomes a new source of noxious stimulation Infiltration of the affected muscles with a local anesthetic drug relieves the contraction and thus eliminates the source of noxious stimulation

Important among the reactions to prolonged noxious stimulation are those which result in the establishment of states of hyperexcitability within the central nervous system Such states, maintained by the constant inflow of impulses from low intensive noxious stimulation,

make possible the intensification of pain from the stimulation of other body regions (secondary hyperalgesia) or the same locality Moreover, there is spread of this disorder within the central nervous system to implicate other segments at segmental and even suprasegmental levels Thus it has been noted that mechanical or electrical stimulation of the mucosa about the ostium of the maxillary sinus at first produces a localized painful sensation in the nose When stimulation is continued, the subject experiences pain which spreads over a portion of the nose and cheek, along the zygoma to the temporal region, into the upper teeth on the same side, and finally the discomfort and reflex muscle and vasospasm involves structures supplied by the first and third divisions of the trigeminal nerve Similarly, noxious stimulation of visceral structures at first produces a true type of visceral pain, but subsequently it produces reflex spasm of the abdominal muscle and other reflex changes which become new sites of pain and discomfort

Current Concepts of the Pain Process

Most people know what is meant by the word pain but have great difficulty in defining it This is because pain is a highly personal affair entirely subjective in nature and a complex physiopsychologic phenomenon which almost defies enquiry Aristotle considered pain as a "quale or passion of the soul a state of feeling, the experience antithetic to pleasure, and the epitome of unpleasantness, together with pleasure, this was the main normal driving force that guided man s actions This concept was embraced by philosophers and accepted as fact until the middle of the nineteenth century, when the newly conceived 'doctrine of specific

nerve energies helped scientists to shake off the metaphysical shackles and to study and consider pain as a sensation Among these scientists were Marshall (71) and Strong (72), who promulgated the concept that pain consists of two elements the original sensation and the reaction to the sensation This concept has been accepted by many students of the pain phenomenon, among whom are Wolff and his associates (69, 73, 74), who have done so much during the past two decades to prove and expound such a hypothesis of the dual nature of pain They consider the total pain experience to be composed of the sensation of pain and all the associated sensations, emotional reactions, and affective states According to them, pain can be separated into two component parts the perception of pain and the reaction to pain

The *perception of pain*, like the perception of other sensations such as temperature and touch, is a neuro physiologic process which has special structural, functional and perceptional properties and is accomplished by means of relatively simple and primitive neural receptive and conductive mechanisms It is measurable and constant, but it can be modified by drugs and psychic factors and completely obviated by interruption of its pathways by chemical (nerve block) or surgical means The *reaction to pain* on the other hand, is a complex physiopsychologic process which involves the cognitive functions of the individual It represents the emotional and physiologic expressions resulting from the perception of pain, it is what the individual feels, thinks, and does about the pain he perceives The pattern of reaction depends in part upon what sensation means to the individual in the light of his past life experience, his attitude toward it his judge

make possible the intensification of pain from the stimulation of other body regions (secondary hyperalgesia) or the same locality Moreover, there is spread of this disorder within the central nervous system to implicate other segments at segmental and even supra segmental levels Thus it has been noted that mechanical or electrical stimulation of the mucosa about the ostium of the maxillary sinus at first produces a local ized painful sensation in the nose When stimulation is continued, the subject experiences pain which spreads over a portion of the nose and cheek, along the zygoma to the temporal region, into the upper teeth on the same side, and finally the discomfort and reflex muscle and vasospasm involves structures supplied by the first and third divisions of the trigeminal nerve Similarly, noxious stimulation of visceral structures at first produces a true type of visceral pain but sub sequently it produces reflex spasm of the abdominal muscle and other reflex changes which become new sites of pain and discomfort

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experience — certainly to the patient This is one of the most important and fundamental facts about pain, it must be accepted with its full implications if one is to be successful in managing patients with intractable pain

Neurophysiology of Pain

The origin of pain may be a stimulus in the somatic or visceral structures of the body acting on the peripheral part of the nervous system Or it may originate in the central nervous system and be projected to a distant part of the body, as is the pain of the thalamic syndrome, the painful aura of sensory epileptiform seizures, or the conversion type of pain hysteria In this book we are primarily concerned with pain of peripheral origin, because it is this type that is most frequently encountered by the practitioner and the one that is manageable with blocks

The nervous pathways for pain arising in the somatic and visceral structures may be said to be organized into three distinct units or relays a) the first relay, or peripheral sensory neurons, b) the second relay, or connector (internuncial) neurons, and c) the third relay, or central sensory neurons Each of the primary pain sensory neurons consists of a cell body located in the sensory root ganglion of spinal or cranial nerves and an axon which bifurcates into a peripheral and central branch The finer central branch enters the central nervous system by way of the sensory root of the involved nerve, while the thicker peripheral branch passes distally to the somatic and visceral nerves to reach the various bodily structures, as shown in Figure 2

It is generally believed that the peripheral branch of each of these neurons ends in tissues as a dense plexi

ment, mood, emotional status, and will, the state of his nervous system and the various cerebral processes, the presence or absence of anxiety, and many other factors Obviously, the reaction to pain is different for each individual, indeed, with the passing of time and the accumulation of life experience, it is never exactly the same for an individual from one time to another

Although this artificial dichotomy of the pain experience has proven useful in studying and understanding it, it is doubtful that there is such a thing as a pure sensation of pain separate and distinct from the influence of reaction (75) Cleavage between primary sensation and the secondary response or psychic processing of the original sensation is difficult to conceive For one thing, the processing of the psychic reaction to the original stimulus probably begins before awareness of the sensation has been achieved There are many (including this writer) who firmly believe that the essential part of pain is awareness and that no other sensation or experience can be termed pain unless it is felt as such (76) Moreover, there are so many neuronal influences modifying the input from a pain source before it reaches awareness that the central perception of pain can be considered to result from many different impulses being registered, interpreted, and synthesized as a unit sensation which is greater than its constituent parts and hence a new entity Thus while the original sensation may be considered the same for all individuals, it loses that sameness as soon as processing begins and it is no longer a pure sensation

The obvious conclusion is that the "quale" or feeling state, i e , the patient's complaints, and his physical and mental responses are the manifestations of the reactions and are the most relevant aspect of the pain

form network of bare nerve endings, which are distributed over an area measuring one square centimeter The controversy as to whether or not these subserve only pain and no other sensation need not detain us here Peripheral neurons mediating pain vary in size, degree of myelinization, and speed of conduction Finally, nerve fibers carrying pain impulses are indistinguishable anatomically and physiologically, whether they arise in the superficial or deep soma or in the viscera All neurons of the first relay, or peripheral, sensory unit, therefore, may be said to begin in the periphery, have their cell bodies in posterior root ganglia, and enter the spinal cord through the posterior roots

Upon entering the spinal cord, these fibers divide into short ascending and short descending branches and thus form the dorsolateral tract of Lissauer They then proceed to enter the gelatinous substance of Rolando, where they terminate and synapse with connector or internuncial neurons within the internuncial pool, or they may cross over in the central commissure to the opposite side to form the lateral spinothalamic tract The lateral spinothalamic tract ascends as an unbroken path within the anterior column of the spinal cord and then through the brain stem to terminate in the thalamus, as depicted in Figure 2

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their cell bodies in the posterior root ganglion and entering the central nervous system via the posterior root as do all other sensory neurons The secondary neurons form the spinothalamic tract which for the sake of clarity is shown here as a compact bundle but which in actuality is more widespread Note the relationship of the tract at various levels and also the topical arrangement of the thalamocortical projection (3rd relay of neurons) (After Rasmussen from Bonica J J *Management of Pain* Philadelphia Courtesy Lea & Febiger Co)

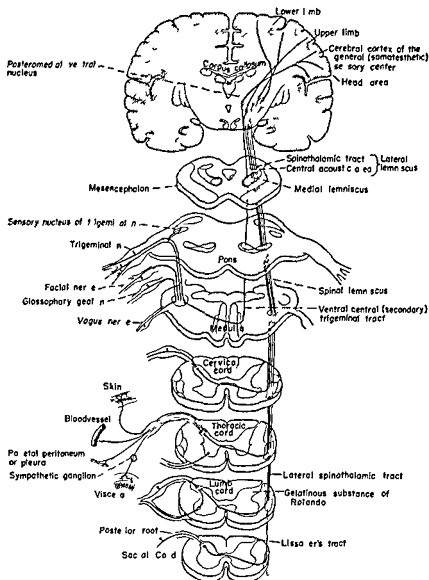


FIGURE 2 A schematic diagram which illustrates the three relays of nervous elements involved in the conduction of pain from the periphery to the brain This figure depicts the course of the peripheral neurons entering the thoracic portion of the spinal cord from the skin blood vessels pleura and peritoneum and from the viscera entering the spinal cord via the posterior root All of these fibers are constituents of spinal nerves having

(Continued on next pa)

The peripheral fibers of these neurons course along the peripheral branches of these cranial nerves, while the proximal fibers enter the brain stem, where they all become associated with the sensory nucleus of the 5th (trigeminal) nerve

Recent work by Magoun and his coworkers (77) indicates that in the brain stem the main sensory pathways send collaterals into the reticular formation They have also determined that certain thalamic nuclei give rise to the ' diffuse thalamic projecting system," which receives somatic and visceral impulses transmitted by the reticular activating system The hypothesis is suggested that these collaterals have as much to do with the conduction of pain sensation as do the main pathways (76, 77)

The pain impulses reaching the thalamus are transferred to central sensory neurons which are located in the thalamacortical radiation These fibers are projected from the nucleus ventralis posterior of the thalamus to the postcentral convolution of the cortex From the nuclei of the diffuse thalamic system there is a projection to the anterior portion of the frontal lobe It has been suggested that it is the disturbance of this mechanism that diminishes the affective component of sensory perception and deprives pain of its unpleasantness (76)

Although pain sensation is probably also integrated in the mesencephalon and thalamus, the cortex is the highest level of such integration that results in the normal apperception of pain The very complex intercommunications which exist between the postcentral gyrus, where are concentrated the thalamocortical projections, and other parts of the cortex result in an intimate functional relationship among these various parts

TABLE I

Nerve Supply of Various Structures

Viscera	*Entrance of Sensory Fibers Into Central Nervous System*	*Level of Origin of Preganglionic Sympathetic Nerve Supply*	*Parasympathetic Nerve Supply*
Aorta			
Thoracic	T1 T5		
Abdominal	T6 L2	T1 L2	Vagus
Heart	T1 T5	Cervical and T1 T5	Vagus
Lungs	None	T2 T7	Vagus
Pleura	Intercostal Nerves	T1 T12	
Esophagus	T5 T8	T2 T5 T5 T8	Vagus
Larynx and Trachea	Superior laryngeal of vagus	T2 T7	Vagus
Bronchi	Vagus	T2 T7	Vagus
Liver and Gall bladder	T5 T9	T6 T11	Vagus
Pancreas	T6 T10	T6 T11	Vagus
Spleen	T6 T8	T5 T8	Vagus
Stomach	T6 T9	T5 T11	Vagus
Duodenum	T6 T8	T6 T8	Vagus
Jejunum and Ilium	T 8 T11	T8 T11	Vagus
Cecum Upper colon	T9 T11	T9 T11 Right	Vagus
Appendix	T10 L1	T10 L1	Vagus
Lower Colon	L1 L2 S2 S3 S4	L1 L4 Left	S2 S3 S4
Adrenal	None	T6 L2	None
Kidney	T10 L2	T10 L2	Vagus
Ureter	T11 L2	T11 T12 L1 L2	Vagus
Urinary Bladder	T11 L1 S2 S4	L1 L2	S2, S3 S4
Testes Epid Vas Def	T10	T10 L1	S2 S3 S4
Prostate	T10 T11 S2 S3 S4	T10 L1	S2, S3 S4
Uterus and Ovaries	T10 T11 T12 S2 S3 S4	T 5 L2	S2 S3 S4
Head	Cranial nerves and C2 C3	T1 T4	Cranial Parasympathetics
Neck	C2 C4	T1 T4	None
Upper Extremity	C5 T1	T2 T8	None
Lower Extremity	L1 S3	T10 L2	None

Pain from the head region is conveyed by receptor neurons which have their cell bodies in the sensory ganglia of the 5th, 7th, 9th, and 10th cranial nerves

visceral pain, follow fixed anatomic pathways which unfortunately are unknown at the present time (49, 78)

Although the actual mechanisms of referred pain are not definitely known, three plausible explanations may be considered (45, 49) In some instances impulses arising from viscera or deep structures enter the spinal cord and reach the cortex There they are misinterpreted as impulses arising from the skin supplied by nerves which enter the spinal cord at the same level as the nerves which convey impulses from the deep structures In such instances there is no hyperalgesia or hyperesthesia, and anesthetization of the area of reference will not affect the pain

The second possible explanation is that in some other instances the noxious impulses arising from the deep structures establish a state of hyperexcitability within the central nervous system, probably involving the internuncial pool of the spinal cord Normal or subminimal impulses arising from the skin supplied by the same spinal cord segment reach the cord, and there they are reinforced (phenomenon of facilitation) and proceed to the cortex, where they are actually perceived as painful Under such circumstances the pain in the area of reference is accompanied by hyperalgesia and hyperesthesia of the same area Due possibly to such summative effects, the reactions to noxious stimulation may be the source of far more suffering than is the pain from the original site of noxious stimulation Injection of a local anesthetic into the painful cutaneous region or anywhere along the nerve pathways will relieve this pain and tenderness

The third explanation is the reflex theory, which suggests that noxious impulses from the lesion cause

This relationship makes possible the mobilization of all sorts of associations based upon past experience and judgments, so that the individual is able to evaluate the particular sensation It is here that the sensation is converted into a painful experience by incredibly complex physiopsychologic mechanisms sensation becomes perception, percepts are further elaborated into concepts, concepts cluster together to form ideas and ideational constellations, and all of these events undergo mnemonic engramatization, i e , formation of memory traces which in part form the basis of the reaction to the sensation Here occurs the formulation of the individual reactions to the perception or appreciation of pain Moreover, it is here that the appreciation of the stimulus is further modified by the state of activity of other cortical centers, particularly those located in the frontal lobe, with the result that the appreciation is aggravated or inhibited

Mechanism of Referred Pain

Frequently the pain and the associated reactions (muscular rigidity, deep tenderness, and sympathetic dysfunctions) resulting from prolonged noxious stimulation of deep tissues are located away from the lesion or site of stimulation — hence the term "referred pain" Referred pain due to visceral disease has a distribution which follows known dermatomes, whereas referred symptomatology of deep somatic stimulation does not follow such known dermatome patterns It should be stressed, however, that the location of the referred pain, tenderness, and muscle spasm consequent to deep somatic stimulation is relatively constant and predictable This fact indicates that impulses concerned in the unfamiliar reference of somatic pain like those of

sickening discomfort which the patient has difficulty in localizing because it is diffuse and is not so rapidly perceived

Pain is rarely constant in intensity for any protracted period The brief, severe, lancinating pain of trigeminal neuralgia is an extreme example, the pain of carcinomatosis is notoriously waxing and waning In addition to intrinsic mechanical and chemical factors which may cause the pain to become more or less severe, environmental changes may be important Pain is generally worse at night because the distractions and mood modifying effects of the day's activities are not present, when the patient is quiet in bed he becomes preoccupied with his condition

There is no constant, necessary or proportionate relationship between the perception of pain and the reaction to that perception The obvious inference of great clinical importance is that the intensity of pain or amount of suffering experienced by the patient is independent of the size of the lesion Although the role of pain appears to be one of warning, its usefulness to the organism in this regard is limited by the fact that it gives no true indication of either the amount of tissue damage or of the seriousness of the damage

Perhaps the paramount factor in determining the intensity of pain and suffering is the significance of its source If there is no worry or other distressing implication regarding its source, pain is comparatively well tolerated This has been emphasized by Beecher (79) who found that only 32 per cent of a group of badly wounded soldiers said they had enough pain to warrant relief, whereas in a similar group of civilians who had had various types of operations which had inflicted far less trauma 83 per cent of the patients

a disturbance in the internuncial pool. This disturbance is reflected by abnormal response from antero-lateral and anterior horn (motor) cells resulting in sympathetic hyperactivity and skeletal muscle spasm, which in turn serve as new sources of pain and reflexes. Early interruption by nerve block of the "vicious circle", either in the afferent or in the efferent side is effective in abolishing the pain.

Pain due to lesions of nerves (neuritis, neuropathy), of nerve roots (radiculitis, radiculopathy), or of the posterior horn of the spinal cord (myelopathy) is frequently projected to the skin and other somatic structures supplied by them and interpreted as being localized there. Examples of such pain are herpes zoster, the pain associated with herniated intervertebral disc, and the pain of trigeminal neuralgia.

The clinical importance of knowing the mechanism of referred or projected pain is obvious. Certainly, for the best therapeutic results it is essential to direct efforts toward the source and not the area of reference.

Some Characteristics of Pain

Noxious stimulation produces pain which differs in its characteristics according to the structures involved. The characteristics of pain of special interest to the clinician include quality, intensity, duration, and extension. Noxious stimulation of superficial somatic structures (skin, subcutaneous tissues) produces pain which has a sharp quality, is well localized, and is felt quickly. Pain induced by noxious stimuli applied to the deep soma (fascia, periosteum, tendon, subcutaneous tissue) is duller and more diffuse than cutaneous pain. Pain resulting from application of pain stimuli to viscera is usually described as a dull, aching,

Another important characteristic of pain is that unlike other sensations it lacks adaptation. Patients with long standing pain do not get accustomed to it but rather seem to get more "sensitive" to it and suffer more with the passing of time. Protracted pain, no matter whether moderate or severe, produces physical and psychologic depletions which vary widely between individuals and may be evidence of basic personality differences.

The presence of general debility, malnutrition, fatigue, anxiety, or mental turmoil decrease further the reaction threshold with the result that the pain is more severe and more difficult to treat. Lack of sleep is particularly important in this respect. Patients with chronic suffering have a gradual but complete alteration in their attitude to their environment. Consequently, they have no other interest and the pain becomes in fact a consuming problem which completely dominates their lives. In such cases interruption of pain pathways with consequent complete abolition of pain perception cannot be expected to solve the problem entirely. In many instances the problem is much more complicated and necessitates a long term application of psychotherapeutic and rehabilitative measures as well.

Summary

In summary it may be stated that pain and associated reactions at local, segmental, suprasegmental, and high integrative levels as a response to noxious stimulation involve four interdependent factors: (1) the incoming impulse from the periphery, (2) the activity of the internuncial pool and disturbance produced therein, (3) hyperactivity of skeletal and smooth muscles,

wanted medication This important difference in the two groups appeared to be due to their respective interpretations of their wounds, the significance it had to the patient In the injured soldier the wound marked the end of disaster and was accompanied by thankfulness at his escape from the battlefield It was associated with little pain and even euphoria (his wound was a good thing) These patients complained as vigorously as normal men do to a venipuncture, indicating that they had a normal sensory apparatus and that there was not total pain block, as has been suggested Apparently in this group the emotion completely blocked noxious impulses arising in the wound from reaching awareness To the civilian his major surgery, even though essential, was a depressing, calamitous event which might end in disaster

Another characteristic of pain is that when two or more sources of pain stimuli exist coincidentally perception of pain is monopolized by the most intense, a point of great clinical significance when treating patients with metastatic lesions or widespread disease Moreover, the intensity of pain is not generally increased by the summation of neural impulses from noxious stimulation at different sites Hardy (74) points out that this lack of summation is beneficial to the organism in that it prevents the overwhelming of the individual by unbearable pain resulting from a summation of effects of multiple noxious stimulations of low intensity On the other hand the magnitude of the associated reactions, which are produced by the noxious stimulations, is increased by the summation of neuron impulses and this is also biologically useful because it facilitates the mobilization of the organism for adaptation and protection

CHAPTER III

INDICATIONS FOR NERVE BLOCKS

As A SUMMARY of the material set forth in the preceding chapter, it may be stated that nerve blocking technics may be employed to produce a complete, reversible interruption of nervous pathways in order to (1) eliminate a local focus of nervous irritation or noxious stimulation, (2) interrupt perception of pain, either at the source or anywhere along the peripheral afferent neurons, (3) interrupt reflex mechanisms which are maintaining an abnormal activity of skeletal and smooth muscles, glands, blood vessels, and (4) eliminate these reflex responses by direct infiltration of the skeletal muscles and other structures involved

Properly carried out, these procedures may be employed as diagnostic, prognostic, prophylactic, and therapeutic aids in the management of many disorders This chapter will be devoted to a brief enumeration of the indications It is by no means complete and many other examples will be mentioned subsequently during discussion of each specific technic Subsequently it will be duly emphasized that for optimal results it is necessary to carry out these procedures properly, select patients carefully, and realize their limitations and disadvantages as well as their advantages

glands, and other peripheral structures brought about by increased stimulation of the lateral and anterolateral horn cells in the spinal cord, and (4) the mental status of the individual at the time the noxious stimulation is received The relative role played by each one of these components varies greatly among different individuals and even in the same individual at different times The most important factor responsible for this great variation is the physiopsychologic makeup of the individual, which in turn depends upon his unbringing, the development of his concepts concerning culture, his society, his religious beliefs, his education, his psychologic development, and many other factors which play a conditioning influence in the formation of the individual's reaction patterns Also important in the formation of the reaction pattern is the site, intensity, and duration of the stimulus, the condition of the peripheral nerves and tissues supplied by these nerves (inflammation of the tissues brought about by infection, chemical agents, etc , makes it more vulnerable to noxious stimulation), and the status of the internuncial pool at a particular time as well as the status of the mind It is obvious, therefore, that, in order to apply properly any method of treatment, it is necessary to study the patient thoroughly so that an attempt may be made to determine the relative role of each of the aforementioned factors

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Diagnostic Blocks

Nerve blocks may be employed to great advantage in helping the diagnosis of many disorders This method is particularly useful in helping the differential diagnosis of disorders which present confusing signs and symptoms in similar locations, such as that of true facial neuralgia from the so-called atypical syndromes, or that of neuralgia involving the third division of the trigeminal nerve from glossopharyngeal or vagal neuralgia It is very useful in helping to differentiate pain of visceral origin from pain of somatic origin For example, in patients complaining of chest pain the primary source of the discomfort may be ascertained by performing intercostal block or cervicothoracic sympathetic block or both Obviously, complete relief of pain following intercostal nerve block suggests the pain to be of somatic origin, whereas relief following the cervicothoracic sympathetic block indicates that the source of discomfort is primarily in the heart or lungs In some instances the significant difference in the neurotomes supplying viscera from those providing the nerve supply for overlying somatic structures constitutes one of the most important basis for the use of diagnostic nerve blocks Pain in the suprapubic region provides a striking example The somatic structures are supplied by the lower two thoracic and the first and second lumbar, whereas the pelvic viscera are supplied by the middle three sacral segments The value of blocking either one or the other or both in ascertaining the source of suprapubic pain is immediately obvious

In obscure epigastric pain, nerve blocks will aid the physician to differentiate between a coronary occlusion and pancreatitis, cholecystitis or ruptured peptic ulcer

They will also help in the differential diagnosis of other chest disorders from upper intra abdominal visceral disease They may be employed with caution in the differential diagnosis of affections of the stomach and lower abdominal disorders of the kidney and appendix, of the gall bladder and kidney, and of the gall bladder and appendix

Properly carried out, nerve blocks are without doubt the most effective means of determining the nervous pathways involved in a painful disorder or reflex disturbance In this way they help to ascertain the mechanism producing this disturbance and thus greatly aid the diagnosis of the disease They are particularly efficacious in determining which of the mechanisms mentioned in the preceding chapter are primarily responsible for the referred pain and associated reactions

The third very important indication for diagnostic blocks is in the determination of the relative role of the components producing the pain and the associated reactions mentioned in the preceding chapter (p 16) Relief of pain and elimination of skeletal muscle spasm, vasospasm, and other associated reactive responses, following infiltration of a local anesthetic drug at the site of the lesion or along the afferent pathway is important presumptive evidence that the local tissue reaction and/or reaction at segmental levels are playing the dominant role in producing the symptomatology There are a number of patients with manifestations of so-called "organic disease who not only derive no benefit from but actually get worse following nerve blocking, despite the objective fact that the autonomic and skeletal muscle disturbances are eliminated Confirmation of these results with a second and a third block would provide important evidence, which indi-

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as an adjuvant to aid the physician in predicting the effects of certain definitive procedures Although this use can be considered as a diagnostic measure, it is mentioned separately to emphasize the importance of this clinical application of nerve blocking Certainly, prognostic blocks can be considered as an indispensable tool in the management of tic douloureaux, causalgia, and other reflex dystrophies, certain neuralgias, peripheral vascular disease, and other conditions which might indicate the necessity of prolonged interruption, either by the injection of neurolytic agents or neurosurgical section Properly carried out this method produces effects similar to those of chemical (alcohol) or surgical section of sensory, autonomic, and skeletal motor pathways and thus lends itself to the proper selection of patients for such procedures

In selected patients nerve blocks may be used to advantage to predict the outlook and duration of the disease and of the therapeutic measure The rapidity, degree, and duration of relief and the elimination of objective signs following a prognostic block together with other information can be employed to determine the chronicity of the condition and to help predict the effects and duration of the treatment

Prognostic blocks are also valuable to the patient himself In painful syndromes which indicate prolonged or permanent interruption of somatic nerves for definitive treatment, nerve blocks with a local anesthetic agent afford the patient an unparalleled opportunity to experience transient numbness and other unusual sensations which frequently follow surgical section Patients are rarely encountered who complain bitterly of the numbness and paresthesia which occasionally follow trigeminal neurotomy for tic

cates that the reaction phase of the disturbance at suprasegmental and integrative levels is playing a dominant role and therefore constitutes the major part of the disturbance Such information considered together with a thorough study of the patient and his personality would be of immeasurable value in helping to make the diagnosis and in planning the form of treatment Obviously, psychotherapy is the most important aspect of the management of such a patient

Nerve blocks may be employed in peripheral vascular disease to help determine the underlying etiologic factors, and to aid in the differential diagnosis between functional spastic disorders and organic obliterative disease Even in the latter group, block may be employed to determine the degree of collateral vasospasm accompanying the organic lesion

Nerve blocks may be employed in certain instances to aid in the differential diagnosis between organic and functional disorders and between organic disorders and malingering However, it cannot be too strongly emphasized that these should be carried out with great caution and only after the patient and his personality, his behavior, and his mental status, among other things, have been thoroughly studied

To make a definite diagnosis and label the patient psychoneurotic solely on the basis that the block procedure did not relieve the pain, constitutes a grievous injustice which can only be avoided by employing nerve blocks as an *adjunct* to the clinical appraisal of the patient

Prognostic Blocks

One of the most important clinical applications of nerve blocks in the management of disease is its use

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douloureux, and after the operation they state they would prefer the original pain to the postoperative abnormal sensation The same problem is rarely encountered following rhizotomy and chordotomy, and can be obviated by injecting the nerves with a local anesthetic or alcohol prior to the operation to allow the patients to choose between the pain on the one hand and the numbness and abnormal sensation on the other It is, therefore, strongly suggested that all patients who are to undergo permanent section should be subjected to two or more prognostic blocks

In patients who are unusually depressed and pessimistic about the nature of the disorder, nerve blocks may be employed as a psychotherapeutic aid Such a "psychologic crutch" is of particular value in the management of patients with severe pain due to a self-limiting disease, of patients who have psychoneurotic tendencies which make them vulnerable to even minor stress, and of those who have an incurable disorder accompanied by pain Demonstrating to the patient that the pain and disturbance of function can be relieved with nerve blocks even though the effects are shortlived, may be the most effective method of reassuring the patient and making it possible for him to accept various other therapeutic procedures

Concerning the proper clinical application of prognostic nerve blocks, several points need to be made In order to obtain optimal results with this method it is necessary to realize its limitations and to consider it as an adjuvant to the clinical evaluation of the patient and other diagnostic prognostic procedures Moreover, in order to obtain accurate diagnostic and prognostic information, it is necessary to carry out the block procedure with small volumes of local anes-

thetic solution and to have roentgenographic evidence of the position of the needles and the diffusion of the solution Moreover, for these purposes, at least two, and preferably three blocks should be carried out to determine the certainty of the effects

Prophylactic Nerve Blocks

Certain block procedures properly carried out in selected patients may be used to prevent the pain and obviate the delay of return to normal functional activity that sometimes follows trauma, infection, or operation These procedures can be considered the most efficient method of controlling postoperative and posttraumatic pain and of preventing vasomotor hyperactivity and visceral dysfunction thus affecting earlier function and rehabilitation Although this may be considered as a therapeutic application of nerve blocks it is mentioned separately for purposes of emphasis

Therapeutic Nerve Blocks

The use of nerve blocks as a definitive therapeutic measure is perhaps their most important clinical application in the management of disease Although their value for this purpose was recognized even before the discovery of the local anesthetic properties of cocaine, this clinical application has not been exploited to the fullest extent This is unfortunate indeed, for when accurately carried out in properly selected cases, it constitutes one of the most effective forms of treatment in managing certain disorders

Nerve blocks afford symptomatic assistance in self-limited disease such as acute thrombophlebitis herpes zoster postoperative pain and posttraumatic pain, certain neuralgias severe acute visceral pain musculo-

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insufficiency produced by embolus, trauma, vasospasm, or a thrombus can be best relieved by therapeutic nerve blocks which are maintained for hours and, if need be, for days In addition to providing comfort for the patient, the block effects the relief of reflex spasm of collateral arterioles and other reflex disturbances which are contributing to the physiopathology of the condition

Therapeutic nerve blocks are indicated in the management of certain patients with severe, intractable chronic pain This is especially true in pain of undetermined origin when there might be a tendency for the busy practitioner to resort to the easier and less time consuming method of using addictive analgesics for a prolonged period of time This is without doubt one of the most serious and often disastrous errors in clinical medicine The physician may be entrapped into committing such an error by a humane, though, ill-considered decision to keep the patient from suffering The administration of narcotics to patients with chronic pain is a frustrating, short lived type of kindness such a sense of mistaken humanitarianism is inevitably productive of tolerance and other phases of addiction It is really a great disservice to the patient because with continued use of the addictive analgesics tolerance to the analgesic action develops until eventually an impasse is reached in which the patient's daily narcotic requirements are high while the alleviation of pain is inadequate

skeletal conditions, and many other transient disorders which are accompanied by severe pain and disturbances in function In some patients the discomfort is of such magnitude that it cannot be adequately relieved with conservative measures even with large doses of narcotics In such instances, nerve blocks constitute the most effective method of treatment, not only because they provide complete relief, but also because they frequently eliminate associated reflex disturbances which are contributing to the physiopathologic process For this reason nerve blocks are especially applicable to the management of acute, severe, posttraumatic pain and the excruciating discomfort consequent to herniated intervertebral disc, fractured ribs, fractured vertebra, severe ligamentous tears, and other acute musculoskeletal disorders The same applies in managing acute segmental or peripheral neuralgia due to any other cause It should be realized, of course, that blocks relieve pain by interrupting pain perception and perhaps by relieving some of the reflex disturbances, but do nothing toward the elimination of the cause Therefore, these procedures are employed only as an adjuvant A definite effort should be made to search for the cause and eliminate it

Nerve blocks may be employed to great advantage as a temporary measure in the management of severe, excruciating pain consequent to visceral disease such as acute pancreatitis, perforated peptic ulcer, severe renal or biliary colic, mesenteric thrombosis, or coronary occlusion Often narcotics, even in extremely large doses administered intravenously, are ineffective and, in fact, may aggravate the problem by increasing the smooth muscle spasm The severe pain that not infrequently accompanies sudden, acute circulatory

principles and observe strictly certain important requisites All of these are fundamental in the practice of medicine But they need to be discussed briefly because they are frequently disregarded by the well meaning, enthusiastic, sciolistic physician

Proper Approach to the Problem

Perhaps the first and one of the most important principles in using nerve block is that the practitioner assume the responsibilities and discharge the obligations as a physician rather than act merely as a technician who is an expert in inserting needles Even in the cases where he is acting as a consultant skilled with nerve blocks, it is important that the physician have an insight into the problem His behavior and attitude toward the patient must be that of a doctor who is particularly interested in the patient's welfare, rather than that of one focusing his entire attention on the interruption of nervous pathways He must bring the patient a quiet and considerate humanity and a confidence and security based on the conviction that he, the physician, will do all possible to help solve the problem He must give the patient the implicit assurance that his individuality is recognized and his problem is not meaningful to him alone

As previously mentioned, these principles are fundamental to the proper application of any method of diagnosis and therapy and constitute attributes of the good physician who practices the art as well as the science of medicine However, this approach is especially important in managing patients with chronic disorders, because frequently they are exhausted both mentally and physically by the time they are referred to the clinician for nerve block Many of these patients

CHAPTER IV

PRINCIPLES AND REQUISITES FOR OPTIMAL RESULTS

THE DECEPTIVE SIMPLICITY of injecting local anesthetic drugs and the success reported in the use of nerve blocks as diagnostic, prognostic, and therapeutic procedures have led many physicians to attempt these procedures without proper preparations in the field As a natural consequence of this error, frequent failures and at times accidents have occurred which have caused this method to fall into disrepute in some quarters and in others have precluded its acceptance as an effective tool in the management of various diseases The poor results and accidents have not been entirely those intrinsic in this method, but have resulted from the failure of the physician to learn the principles involved in its use, to master technics of nerve blocking, and to realize its limitations These physicians failed to appreciate one of the basic tenets of the practice of medicine In order to obtain optimal results with any method it is necessary to avoid its indiscriminate employment Blocks should not be used as something innocuous to try out — much as one would administer aspirin for a minor complaint For optimal results it is essential to follow certain basic

and effort, more than some practitioners are willing to spend But unless the physician is willing to devote the necessary time, patience, and energy to the problem, he cannot hope to achieve optimal results In fact he may do more harm than good This is particularly important in the complicated problem of obscure pain and associated symptoms of the intractable variety, in which the diagnosis and localization of its source requires thorough detailed examination and a correct interpretation of medical, neurologic, radiologic, and laboratory data

At this juncture it is important to interject a few words regarding the responsibility of any physician who is acting as a consultant to the patient s physician Since the success of the over-all management of the patient with a chronic disorder depends in a large measure on the development and maintenance of unswerving confidence in his personal physician, it is the duty of all consultants not to say or do anything which will cause deterioration of that confidence

Determine Proper Diagnosis

It is essential for the physician to make, confirm, or reject the diagnosis This point is especially directed to the practitioner who is skilled in the execution of nerve blocks and thus is frequently requested to perform these procedures in patients with a disease already diagnosed perhaps by a very reputable diagnostician Even if the diagnosis is obvious, it is advisable that the physician investigate the problem fully, because in some cases additional information may be obtained which will aid him in performing his task better To accomplish this, a detailed history and thorough physical examination are necessary Performing these duties

have been seen and treated by "charlatans" and "quacks" as well as by well meaning physicians Since pain is both a sensory and emotional experience, management, to be successful, needs to be directed simultaneously toward several aspects of the total experience As previously inferred, nerve blocks most frequently constitute an effective tool though merely an adjuvant part of the therapeutic plan

It is not superfluous to mention once again that the most important factor in the proper management of chronic disease, but especially chronic intractable pain, is the performance of the physician If the physician focuses attention on the symptoms or views pain traditionally as merely a manifestation of physical disease instead of considering the whole person, and if he further disregards the emotional changes that arise with such disorders, proper management is impossible Such a physician finds it necessary to administer narcotics frequently, and because he offers nothing else, he tends to encourage the use of these drugs and make them essential to his patient On the other hand, the attentive physician, who offers his patient sympathetic understanding, kindness, cheerfulness, steady psychologic support, and a realistic perspective, realizes optimal results with minimal deleterious effects to the patient

It is apparent that the physician must give the patient with chronic pain and other disorders an intelligent appraisal in order to make a diagnosis of the overall disease, he must understand the underlying mechanisms and formulate a systematic plan for relief that will conserve the patient's physical, mental, and moral resources and his social and economic usefulness It becomes immediately obvious that the proper management of these patients requires a great deal of time

patient obtained relief, and, of course, a markedly weakened extremity However, three months later she began to have severe, excruciating, burning pain of the entire extremity, probably as a result of the chemical neuropathy and, of course, the weakness which had followed the block persisted The pain became progressively worse and finally, in apparent desperation, the physician proceeded to amputate the patient's leg Soon after the operation the patient began to experience phantom limb which became intensely painful Despite large doses of narcotics, the pain became progressively worse and finally prompted the physician to refer the patient to this writer for further management A detailed history, together with clinical and laboratory findings, made it obvious that the patient had a large herniation of the lumbosacral intervertebral disc Subsequently a chordotomy was carried out with good results

Even in clear-cut cases, it is important for the physician to follow these procedures Certainly no surgeon would proceed to carry out a surgical operation on the advice or suggestion of a referring physician without examining the patient thoroughly and obtaining a complete history of the disease No internist would treat a patient for heart disease or diabetes unless he had made the diagnosis, nor would a neurosurgeon carry out a rhizotomy or chordotomy unless he first obtained a thorough history and examined the patient to ascertain the diagnosis Why then should the physician who is skilled with nerve blocks be expected to carry out one of these procedures without first similarly thoroughly studying the patient and his problem?

Of course, in some instances the block procedure

will afford the physician the opportunity to become acquainted with the patient, to investigate his personality, and what is most important, to establish rapport with him and win his confidence — factors which are so important in the management of any patient, but particularly those with intractable chronic pain

It must be emphasized that one of the most grievous errors in medicine which preclude optimal results is for a physician to perform blocks without adhering to this most essential principle The patient is met at the office or in the emergency room, requested to disrobe, and before he knows it, he is being stuck with a needle, without even having the opportunity of learning the name of the physician Such practices are to be deplored, for they not only cause this method to come to disrepute, but more important, are frequently productive of more harm to the patient Many cases could be cited to emphasize this point but the following tragic story suffices

> F A, a 47-year old female, consulted her physician soon after she began to experience pain in the back of her thigh She was placed on conservative treatment consisting of physical therapy and analgesics but despite the protractive and intensive use of these measures, the pain became progressively worse, and finally became intolerable This prompted the physician to carry out a sciatic nerve block which effected dramatic, complete relief of pain for several hours for which the patient was most appreciative During the next ten days the procedure was repeated four times with similar results Finally the physician carried out the block with 95 per cent alcohol The

dromes, and other acute disorders characterized by a vicious circle

It is necessary then to decide what is the purpose of the procedure, that is, whether it is being performed for diagnostic, prognostic, prophylactic, or therapeutic purposes Occasionally a nerve block produced to aid the diagnosis or to predict the effects of more radical measures produces sufficient relief for a prolonged period of time as to be of therapeutic benefit

Selection of the Best Nerve Block Procedure

Once it has been established that nerve blocking is indicated, it is necessary to decide the best regional anesthetic method, the best technic to carry it out, the optimal site of injection, and the best agent for the purpose on hand This requires a thorough knowledge of the disease, consideration of the possible nervous pathways involved in the physiopathology, and a thorough knowledge of all the technics that could be possibly employed to produce the interruption, including the advantages, possible hazards and disadvantages of each, and familiarity with all the drugs that may be employed

It is also essential to execute the procedure at the optimal time Diagnostic blocks should be done only when the pain and associated physiopathology are present, and preferably when they are most severe Execution of such a procedure at any other time will not provide clear-cut evidence as to the effects of the block, and it may appear a useless procedure which needs to be repeated If the patient is receiving addictive analgesics or other depressant drugs, the time of the block should be spaced so that it is carried out

is being considered in order to establish diagnosis However, in such cases it is even more important to obtain a thorough history and physical examination in order to correlate these findings with the results of the block

Need to Determine Indication of Block

Once a diagnosis has been made, it is necessary to determine whether nerve blocking is indicated or not For optimal results, it is absolutely essential to employ these procedures in indicated cases only, for unless the haphazard and careless selection of cases is avoided, the results will be poor and the method will come into disrepute In fact, as previously indicated, the physician can do more harm than good if he assumes or even condones the deplorable attitude toward nerve blocks of "Let's try it out and see if it will work — we've got nothing to lose" If the blocks are not indicated, there is a great deal to lose — the confidence of the referring physician and of the patient who might be left disillusioned, skeptical, and critical of further treatment to the point of being uncooperative during future therapy

On the other hand, if nerve blocks are indicated, they should be employed as soon as possible before the patient becomes addicted to analgesics, or before the condition progresses to such a degree of chronicity that it will become intractable to any form of therapy This method should not be considered as a "court of last resort," but must be employed early in the course of the disease when the block procedure may effect a reversal of the physiopathologic process and even a cure This is especially true in causalgia and other reflex dystrophies, phantom limb pain, myofascial syn-

practice these procedures on such patients is not only unfair, but will preclude optimal results Since experience can only be gained from performance, it is suggested that the physician who assumes the responsibility of executing nerve blocks for the management of medical disorders becomes skillful and dexterous by first performing them repeatedly for surgical anesthesia Moreover, it is suggested that, except for the simplest of nerve blocks, procedures be learned and performed under the supervision of a physician who is especially skilled in executing them, in teaching the technic, and in the proper clinical applications for diag nostic and therapeutic purposes

Proper Preparation of the Patient

Proper preparation of the patient prior to the block is essential The importance of developing rapport with, and winning the confidence of, the patient has been emphasized along with various other aspects of his psychologic preparation In addition the patient should be informed about the various phases of the procedure The purpose of the block the effect that may be expected, what may be accomplished, and what is being sought must be clearly explained to the patient at the end of the initial interview and before the actual time of the block If it is explained beforehand that the initial block may not produce the desired effects and that several procedures may be necessary before the efficacy of the method can be determined the pa tient is less likely to become discouraged before the whole treatment has been completed

The necessity for his cooperation should be particu larly emphasized, for an informed patient is likely to be a cooperative patient Though such preliminary dis-

after the effects of the medication have disappeared On the other hand, in the patient who is receiving repeated nerve blocks for continuous relief, the injection should be repeated at sufficiently close intervals to provide uninterrupted relief so that he does not have any period of discomfort

Necessity of Experience with Selected Nerve Block Procedure

A most important requisite for obtaining optimal results with nerve block is the proper execution of these procedures Nerve blocks must be performed carefully and correctly with meticulous attention to the anatomic detail and with utmost skill and gentleness The practitioner should be fully acquainted with the structures that are traversed by the needle and the complications inherent in such procedures It bears emphasis that haphazard introduction of a needle in the general area in the hope that it will be anesthetized is fraught with the danger of complications and failures and must be abandoned Unpredictable variations in anatomy and tissue responses and in the approach to nerves through the intact skin impose enough inaccuracy without introducing the additional one of improper execution due to lack of knowledge of technic This is particularly important when the block procedure is done for diagnostic or prognostic purposes because in such instances much depends on the results of the procedure It is therefore essential to localize exactly and precisely the involved nerves and to employ small amounts of solution

Many patients have experiences of prolonged suffering and consequently tolerate very poorly a nerve block procedure carried out crudely and unskillfully To

Appreciation of Limitations of Nerve Blocks

One of the most important requisites in the clinical application of nerve blocks is for the physician to keep constantly in mind that this method, like all other medical measures, has certain limitations, disadvantages, and sometimes contraindications It must be realized that this method, in most instances, contributes only a small part to the total solution of the problem and is thus to be considered as an adjunct for other methods of therapy, rather than the sole form of treatment This is particularly true in the management of patients with chronically painful conditions or other complex problems Many of these patients require painstaking questioning, examination, study, and prolonged treatment by many specialists who jointly may be able to contribute to their welfare Since multitudinous factors may underlie a patient's problem of chronic pain and since failure to consider and treat all these factors precludes a successful outcome, such problems are infrequently solved by any one practitioner or specialist working alone These are the prime reasons why nerve blocks alone fail to provide complete relief to many patients with chronic pain or even a solution to the problem, but must be considered as one contribution of many to a planned attack upon the patient's problem This is emphasized to an almost boresome degree lest the physician who is particularly skilled in regional anesthesia labors under the misconception that complete chemical interruption of nervous pathways should be sufficient to provide the patient with pain relief

To the uninitiated or the naive, such emphasis may seem unwarranted or even imponderable Its appreciation, however, is the critical factor which will spell success or failure with this procedure To clarify this

cussion often consumes more time than the physician thinks he can afford, this is far from true If the patient is uncertain whether he or she wants to accept the recommended procedure, it is best to postpone it to give the patient an opportunity to consider it and to return at a later date

In addition, it is important to have rapport with the patient's family and other physicians involved in the case, for, as previously mentioned, the management of the patient not infrequently requires the joint effort and cooperation of many individuals Moreover, throughout these discussions the physician must demonstrate full confidence in this form of management, for unless the physician believes in the method himself, the results will be uniformly poor, no matter how effectively the pathways are interrupted

Preliminary depressant drugs should be avoided where practical for diagnostic and prognostic blocks because the groggy patient is incapable of making accurate observation Moreover, many of the barbiturates and narcotics produce effects which confuse the issue and preclude proper evaluation of the results The incidence of reaction from local anesthetic drugs is so minimal that the routine use of barbiturates is not justified On the other hand, if the patient is apprehensive and the block is being performed for therapeutic purposes medication may be given before the block (see page 66)

Psychic discomfort can be significantly reduced by (1) avoiding comments which will frighten the patient, (2) by being certain that the patient does not see the needles and other equipment which might frighten him, and (3) by warning the patient just prior to executing any procedure that might cause discomfort

physician who has the interest, capabilities, time, and the tenacity to face repeated discouragement may qualify for the position of the over all manager of the patient and be responsible for the patient's care

In passing, it might be mentioned that the formation of a true "Pain Clinic" and the active participation of the physician particularly interested in nerve blocks in such a group is of great value in the management of these problems Such a clinic should be under the direction of a highly trained individual, particularly interested in and thoroughly familiar with all phases of pain and its management It should include a neurologist, a neurosurgeon, a psychiatrist, an internist, an orthopedist, a radiologist and a physiatrist, in addition to the anesthesiologist This group can review difficult diagnostic or therapeutic pain problems, or both, and thus act in a consultant capacity Moreover, the meeting of such a group affords an excellent opportunity to exchange ideas and knowledge about many of these difficult problems A distinction should be made between "Pain Clinic" and "Nerve Block Clinic" The purpose and function of a Nerve Block Clinic is to integrate the activities of physicians who are interested in managing disease with nerve blocks

Appreciation of Disadvantages of Nerve Blocks

One of the most significant requisites for optimal results with nerve block is a proper appreciation of the disadvantages inherent in this method For one thing, failures unfortunately occur all too frequently Some of the many factors that take part in producing such failures include (1) difficulty in identifying pain pathways, even after careful diagnostic procedures (2) anomalies in bony landmarks and location of the

point further, it is necessary to indicate the possible role of the physician who is particularly skilled in executing nerve blocks in managing patients with various chronic disorders. Such a physician, whether he be an anesthesiologist, a general practitioner, or another specialist, may assume one of two roles: he may be the provider of special technical aid which serves to promote the over all management by diagnostic or therapeutic procedure, or he may be the individual responsible for the over-all management of the patient.

In most instances he will be the first, and he will act as a consultant whose contribution will, of necessity, be an exercise rather than a discipline since the procedures he can offer are inherently limited in their place among the many things which must be done for patients with severe or chronic disorders. While it is true that the anesthesiologist has certain attributes which make him fit to make a significant contribution toward the solution of the problem, it is important that he be cognizant of the great difference between individual technical procedures for the prevention of pain perception and the interruption of other nervous impulses on the one hand, and the broad general problem of the management of a patient with a serious pain problem on the other. The latter implicates total or ultimate management of a case and requires a thorough knowledge of the patient and his disease and may entail many unusual diagnostic procedures involving neurologic, radiologic, laboratory, and various other data which must be properly integrated and interpreted. Moreover, the case may involve definitive, therapeutic, and rehabilitative measures which may be outside the sphere of any single practitioner. Any

realize that in this method is inherent a certain amount of discomfort and that it is occasionally followed by certain complications. Although the degree of discomfort can be reduced by the proper psychologic and pharmacologic preparation of the patient, and the use of sharp needles, proper technic, and gentleness and dexterity, it cannot be totally eliminated without the administration of a hypnotic or anesthetic. The incidence of complications in experienced hands is very low, but they still occur. Since many of these patients already have psychologic and physiologic depletions, they tolerate complications less than the surgical patient. For these and other obvious reasons, every effort should be made to avoid such complications.

Assessment of Results

The last principle and requisite which needs to be mentioned is the careful assessment of the results in as an objective manner as possible. Observations of the reaction of the patient to the formation of intracutaneous wheal and to the insertion of the needle through pain sensitive structures, and to paresthesias, aids in evaluating him. Following the block, the completeness of interruption should be ascertained. When the accuracy of the block procedure is established the desired effects for relieving pain and other disturbances must be assessed carefully. This may require observation from a few hours to several days or weeks.

The amount, the type, and the duration of relief of symptoms should be noted and recorded carefully. Evaluation by the physician performing the nerve block should be correlated with the observation of the patient made by the nurses, resident staff, and the referring physician. The complaints of the patient, the amount

nerves, (3) the necessity of using small volumes of solution, and (4) the fact that in many instances the physiopathology is a complex process involving peripheral structures, the central nervous system, and particularly the mental attitude of the patient and his subjective reactions which are difficult to interpret.

Another difficulty is that although in some cases it is simple for the patient to state explicitly the degree of pain or the degree of relief, in most cases of long-lasting intractable pain, he is unable to state exactly how the block modified his pain. This is understandable when we consider that many factors may modify his reaction to the change produced by the procedure.

There are no absolute contraindications of nerve blocks except lack of knowledge, skill, and patience on the part of the physician employing it. However, it is best to avoid this method in patients with infection at the site of injection, especially in those who have diabetes and in those who are debilitated or in shock, if the technic entails the use of large volumes of local anesthetic solution or the production of extensive vasomotor paralysis. This and other procedures, should be avoided in psychoneurotic and psychotic individuals who invariably not only derive no benefit from nerve blocks, but are actually aggravated by the procedure. In some such patients, nerve blocks may be indicated as a diagnostic procedure or as part of psychotherapy. When this is the case, these procedures must be performed with utmost skill and the physician performing them must exercise his best art of medicine and integrate his activities very closely with those of the psychiatrist.

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of narcotic analgesic required for comfort and the deportment of the patient in general are valuable data, which must be carefully considered for proper evaluation of the results When alcohol is used, no decision as to the efficacy of the block should be made until several days have elapsed, because not infrequently maximal effects following the use of this agent do not occur until such a period of time has elapsed

CHAPTER V

GENERAL COMMENTS CONCERNING TECHNICS

THERE ARE CERTAIN basic principles concerning technics and the use of drugs which are most important for proper application of this method. Although some of these have been alluded to in previous pages, they are mentioned here again for emphasis.

PRELIMINARY PREPARATIONS

Preliminary Discussion with the Patient

In order to obtain optimal results with nerve blocks, it is essential to inform the patient of the details of the block technic and the beneficial and side effects that may be expected therefrom. If paresthesia is to be elicited, it is necessary to explain to the patient what he or she is to expect. This can be described as a "feeling of electricity" in the distribution of the involved nerve. The patient is instructed to promptly signal the physician as soon as paresthesia is felt by snapping out a predetermined sound such as the word "now." The importance of avoiding sudden movements should be stressed. The patient should be convincingly reassured that everything will be done to minimize the discomfort, that he will be warned before each step of

the procedure is carried out, and that he will be permitted to ask for a brief rest at any time he deems it necessary If this practice is followed assiduously and intelligently the confidence one may invoke in the patient outweighs the advantages of sedative drugs and makes their routine use unnecessary

This briefing should be carried out at the end of the initial visit and repeated again each time the block procedure is to be executed Failure to do so is a major source of poor results and confusion The patient should be given the opportunity to ask questions and satisfy himself as completely as possible concerning the details of the procedure

It is also advisable to obtain a written consent for performance of the procedure This is particularly important when in the contemplated technic are inherent serious potential hazards, and in every instance when it is necessary to employ a neurolytic agent such as alcohol It is, of course, important to present this matter to the patient in such a fashion as to prevent him from becoming apprehensive or discouraged about the method

Examination of the Patient Just Prior to the Block

In addition to the examination that is done to establish the diagnosis, a preliminary examination should be done prior to every block procedure Blood pressure, pulse, and respiration should be noted and recorded In addition, it is essential to determine whether the patient has hypalgesia, analgesia, or any other sensory changes, motor dysfunction, or reflex abnormalities Failure to carry out these procedures, especially when the block is being done for

diagnostic or prognostic purposes, will not only preclude a proper diagnosis, but may also cause the physician to be misled into a serious error In passing, it should be stressed that this type of information is also important from a medico legal standpoint and should be recorded in detail

Place Where the Block Is Performed

Since most nerve block procedures have the potential danger of complications, it is necessary to carry out the block in a place where resuscitative equipment is available for immediate use With such equipment available it is permissible to perform some of the minor procedures such as infiltration or injection of small peripheral nerves in the office or in the patient's room in the hospital On the other hand, it is much safer to carry out any block which entails the use of large volumes of local anesthetic drugs (and the consequent potential danger of toxic reaction), paravertebral injection, injection into the epidural or subarachnoid space, or any other procedure which may produce serious complications, in the surgical pavilion where special tables and resuscitation equipment are always at hand Furthermore, in executing procedures that are to be of diagnostic or prognostic value in patients with peripheral vascular disease, it is advisable to carry them out in a room with constant temperature and humidity

It bears reemphasis that *no nerve block should ever be carried out unless measures for resuscitation and treatment of complications are available for immediate effective use* In addition to the resuscitating equipment depicted in Figure 3, it is advisable to have drugs to combat hypotension and other untoward reactions

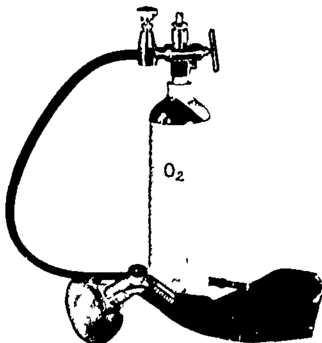


FIGURE 3A Part of the apparatus for resuscitation consisting of an oxygen tank with reducing valve tubing mask and a reservoir bag (Courtesy Foregger Co)

These should include a vasopressor drug such as ephedrine, Neosynephrine or Vasoxyl, an ultra fast-acting barbiturate such as Pentothal or Surital, and a rapidly acting muscle relaxant such as Anectine or Sucostrin In performing the more major type of block procedure, it is also advisable to have equipment to perform resuscitation in case of cardiac arrest

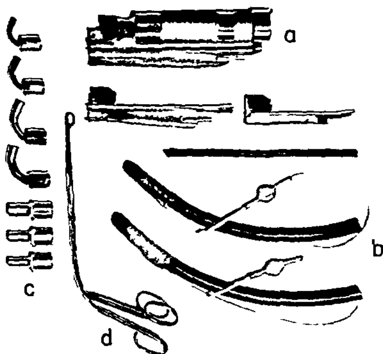


FIGURE 3B Part of the apparatus for resuscitation consisting of (a) laryngoscope with detachable blades of three different sizes (adult child and infant) (b) endotracheal tubes with inflatable cuffs (c) connectors used to adapt endotracheal tube to oxygen resuscitative apparatus and (d) Magill forceps used to guide the tubes into the larynx

Position of the Patient

The patient should be placed in the position which best facilitates execution of the block and have the patient as comfortable as possible Soft cushions should be placed wherever needed to avoid discomfort due to the pressure of bony prominences on the table and to obtain as much relaxation as possible The recumbent position should be used whenever possible because it is the best for the patient and will minimize the occurrence of syncopy during the procedure

Medication Before and During the Block

The importance of avoiding depressant drugs in patients who are to have a diagnostic prognostic procedure has been duly stressed. There will be circumstances, however, when the apprehension of the patient makes it impossible or difficult to carry out a procedure. In such instances it is advisable to employ very small doses of sedatives, such as 50 to 100 mgm of Pentothal sodium injected intravenously. This affords a peak effect which lasts three to five minutes, during which time the block may be performed. In most instances, the patient has no memory of the procedure. In addition, this has been found to obviate psychogenically induced sympathetic stimulation the signs and symptoms of which simulate toxic reaction to local anesthetic and vasoconstrictive drugs.

Of course for therapeutic blocks one may use very heavy medication if this is necessary. Patients who are to undergo extensive procedures such as subarachnoid alcohol block or those who are experiencing pain should be given an appropriate dose of narcotic intravenously about ten minutes before the block is to be carried out. In some of these patients it will be necessary to give, in addition, a small dose of Pentothal or Surital while the nerve block is being carried out and after, as previously mentioned.

Equipment for Block

The type of equipment used matters little so long as it is in good condition the needles sharp and patent, the syringes in good working order and well fitting, and the block tray adequately stocked with other necessary instruments.

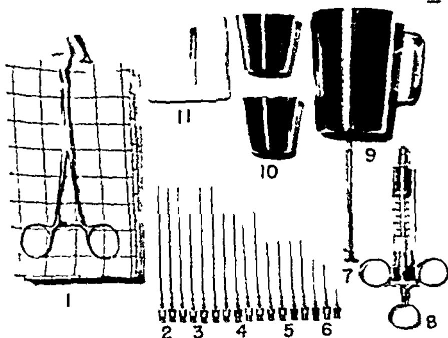


FIGURE 4 Tray containing equipment necessary for most nerve blocks (1) towel and sponge forceps (2) 12 cm (5 inch) 22 gauge needles (3) 10 cm (4 inch) 22 gauges needles (4) 8 cm (3 inch) 22 gauge needles (5) 5 cm (2 inch) 22 gauge needles (6) 25-gauge needles for skin wheal and 21 gauge needle for general use (7) tuberculin syringe to measure the vasoconstrictor (8) Luer lock control syringe (9) large container for local anesthetic solution (10) smaller containers for antiseptic and saline solutions and (11) sponges and ampule files

Since the equipment to be used varies with each block procedure and also among different physicians a detailed description is omitted Figure 4 is included for the sake of completeness It depicts various types of needles, as well as other basic and essential material

Identification of Landmarks

It is advisable to identify the anatomic landmarks

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is not patent is made after a long and arduous placement of the needle

It is advisable to prepare the solution just before the block is carried out Sterile stock solutions by reputable pharmaceutical firms may be employed and are efficacious providing the container has been sterilized with heat (autoclave) and is opened just prior to the block Solutions that have been exposed to air, heat, or light might be decomposed or concentrated and should not be employed This preliminary check of equipment and preparation of solution should be done out of the sight of the patient

For most procedures the needle is introduced unattached to the syringe to facilitate discovery of the inadvertent invasion of a blood vessel or of the subarachnoid space It may be advantageous to thread a small piece of sterile cork or rubber on the shaft of the needle to be used as a depth recorder In most instances the needle is introduced perpendicular to the surface of the skin

Unless it is especially indicated, one should avoid intraneural injections since these are conducive to the production of postinjection neuropathy For the same reason it is essential to avoid trauma to nerves induced in the process of eliciting paresthesia Although paresthesia is almost indispensable in establishing diagnostic or prognostic nerve blocks, promiscuous, repeated and rough probing of nerves should be avoided, instead one should exercise gentleness, skill, dexterity, and avoid haste

Injection of the anesthetic solution into deeper tissues must always be preceded by an attempt to aspirate in two planes in order to avoid inadvertent intravascular or subarachnoid injection An additional

necessary for the performance of the block before the physician puts on sterile gloves and the antiseptic solution is applied This step has the advantage of permitting the operator to get a good perspective and palpate the area without fear of contamination The landmarks may be marked with skin pencil or methylene blue if this is deemed advisable

PRINCIPLES OF TECHNIC

Asepsis

It is hardly necessary to emphasize the importance of carrying out block procedures under strictly aseptic conditions This is, of course especially important when the block procedure entails invasion of the subarachnoid space, paravertebral region, sacral canal, epidural space, or any other region of the body where an infection might be a serious problem After the site of injection has been adequately prepared towels should be placed so as not to obscure the landmarks or distort the perspective of the field for the physician

Check and Proper Use of the Equipment

It is desirable to use a needle sufficiently long that it is unnecessary to introduce it as far as the hub Most procedures may be carried out with 22 gauge or 25 gauge needles For most regional procedures a 10 ml syringe with side rings (the so-called ' control" syringe) is preferred because it permits better control and facilitates the ' aspiration test No needles should be inserted until they have been tested for sharpness, hooks, and especially patency by the injection of saline through them It is not an infrequent omission which is most disconcerting to the physician and to the patient, especially when the discovery that the needle

is not patent is made after a long and arduous placement of the needle

It is advisable to prepare the solution just before the block is carried out Sterile stock solutions by reputable pharmaceutical firms may be employed and are efficacious providing the container has been sterilized with heat (autoclave) and is opened just prior to the block Solutions that have been exposed to air, heat, or light might be decomposed or concentrated and should not be employed This preliminary check of equipment and preparation of solution should be done out of the sight of the patient

For most procedures the needle is introduced unattached to the syringe to facilitate discovery of the inadvertent invasion of a blood vessel or of the subarachnoid space It may be advantageous to thread a small piece of sterile cork or rubber on the shaft of the needle to be used as a depth recorder In most instances the needle is introduced perpendicular to the surface of the skin

Unless it is especially indicated, one should avoid intraneural injections since these are conducive to the production of postinjection neuropathy For the same reason it is essential to avoid trauma to nerves induced in the process of eliciting paresthesia Although paresthesia is almost indispensable in establishing diagnostic or prognostic nerve blocks, promiscuous, repeated and rough probing of nerves should be avoided, instead one should exercise gentleness, skill, dexterity, and avoid haste

Injection of the anesthetic solution into deeper tissues must always be preceded by an attempt to aspirate in two planes in order to avoid inadvertent intravascular or subarachnoid injection An additional

precaution is to inject a small amount of air or saline solution in order to dislodge any structure that might be against the bevel of the needle prior to performing the aspiration test It is also advisable to detach the syringe from the needle and observe the hub of the needle for fluid or blood for a period of 15 to 20 seconds

Care of the Patient During the Block

As previously mentioned, the patient should be warned immediately prior to carrying out any of the steps of the block, such as the painting of the skin with a cold solution, the formation of the intracutaneous wheal, etc Such warnings, together with constant encouragement will help the patient to better tolerate each of these procedures If at any time the patient complains unduly of discomfort, it is advisable to inject a small amount of local anesthetic solution and/or give the patient a few minutes rest

It is advisable to have someone else to attend the patient Constant encouragement by the attendant and the operator will do much to minimize mental discomfort for the patient If the patient experiences severe pain, it may be advisable to administer a small amount of hypnotic or narcotic drug In some instances it may be necessary to carry out the procedure under general anesthesia However, I would hastily add that this should *never* be done if the patient's cooperation is necessary in carrying out the block and in detecting complications

Aids to Facilitate Nerve Block

In recent years there has been a progressive increase in the use of roentgenograms as auxiliary aids in diag-

nostic and therapeutic nerve blocking to facilitate the proper placement of needles This practice is especially useful in carrying out interruption of sympathetic pathways in which the elicitation of paresthesia, as frequently used with somatic blocks, cannot be employed to aid in properly placing the needle This practice is also useful in blocks of the cranial nerves in patients who have tumors that increase the difficulty of inserting the needle into one of the foramina, and in patients who require paravertebral or sacral blocks, especially in those with kyphosis, lordosis or scoliosis, or other musculoskeletal disorders which present difficult and sometimes dangerous obstacles to nerve blocking

In addition to being valuable adjuncts for the proper placement of the needle, x rays serve as excellent objective records of the procedures, and when they are combined with a description of the technic such as contained in the block records, a most complete story of the procedure is available for future reference

Preliminary injections of 35% Diodrast or other contrast media with subsequent visualization prior to the injection of the local anesthetic solution has also been employed to predict its spread

In order to be of greatest value, the roentgenograms must be taken from the proper angle Anteroposterior and lateral views must be made whenever possible to locate the tip of the needle accurately in both planes In some instances it will be necessary to make stereoscopic views Moreover, interpretation of the results requires serious study and experience

CHAPTER VI

AGENTS USED TO PRODUCE NERVE BLOCK

THE PROPER CHOICE of the solution for injection in order to produce nerve block is one of the most important requisites for optimal results The agents used for this purpose are of five general groups (1) aqueous solutions of local anesthetic agents, (2) oil solutions of local anesthetic agents, (3) long acting agents which produce their effect by partial or complete destruction of the nerve, (4) drugs which are said to have a specific affinity for a particular type of fibers, and (5) a miscellaneous group which includes saline, corticoids and boiling water

The selection of the optimal agent will depend upon the serious consideration of several factors, including (1) the purpose of the procedure, (2) the physician's knowledge of the properties and experience with these various drugs, (3) under what circumstances the block is to be employed (outpatient or hospital patient), and (4) the physical condition of the patient, including history of sensitivity or susceptibility to a particular group of drugs Although it is not within the scope of this monograph to discuss in detail these various agents, a few brief remarks are in order

AQUEOUS SOLUTIONS OF LOCAL ANESTHETIC DRUGS

Aqueous solutions of the commonly employed local anesthetic drugs are the most satisfactory solutions for the production of diagnostic and prognostic blocks. In addition to the fact that their action is reversible within a few hours, they offer the advantage of being relatively safe and of producing little or no effect upon tissues adjacent to the nerves. For these and other reasons, they are also most frequently employed for therapeutic blocking, especially in patients who are suffering from a disorder produced and maintained by abnormal reflex mechanism and the so-called vicious circle. As previously mentioned, the beneficial effect of such a block frequently outlasts the duration of the interruption. This observation has been confirmed on innumerable occasions and leaves one to suspect that block procedure has successfully interrupted the reflex mechanisms as discussed on page 16.

There does not seem to be any reliable evidence which indicates that any one local anesthetic agent has outstanding superior qualities. Serious consideration of the characteristics that the so-called ideal local anesthetic drug should possess reveals that unfortunately such a drug has not yet been made available. On the other hand, each of the local anesthetics presently available for clinical use may be employed to good advantage, provided its properties are well known and taken into consideration. In passing, it should be mentioned that many clinicians hold serious misconceptions concerning local anesthetic drugs which need to be revised. Certainly the claim made by pharmacologists and repeated by those who have had

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closely related to procaine, consisting of the standard drug with a chlorine radical on the benzene ring Clinical studies and use have revealed that this drug possesses the following outstanding advantages over the standard drug (1) the production of very rapid anesthesia, (2) marked penetrance, which is responsible for rapid onset and higher incidence of complete blocks, and (3) apparently the least toxicity of all the local anesthetic drugs available at the present time

In view of these properties, this drug is particularly useful in diagnostic and prognostic blocks, especially in outpatients Although the duration of anesthesia produced by Nesacaine is slightly longer than that by procaine, it falls far short of the length of block produced by a number of the other drugs It is not advisable to use this drug for spinal anesthesia because its marked diffusibility causes it to provide less control than other agents presently available

Ravocaine

Ravocaine is another analogue of procaine which possesses greater potency and produces much longer anesthesia than the parent drug In equiactive concentration it also produces more rapid anesthesia than procaine (80) Although this drug needs further clinical use before its relative merits can be determined, it is mentioned here because it is now clinically available

Xylocaine (Lidocaine)

Despite the fact that it was introduced into clinical practice relatively recently and that its toxicity is ap-

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* Although it is more proper to use the official U S P non proprietary names of local anesthetics the proprietary names will be used henceforth for all drugs except the standard agent Procaine because they are better recognized by most clinicians

little experience with local anesthetic drugs that procaine is the safest and most satisfactory agent has not been borne out in widespread clinical practice of regional anesthesia

In determining which of the local anesthetic drugs is best for a particular regional anesthetic procedure in a particular patient and under specific circumstances, it is necessary to consider the following essential characteristics (1) anesthetic activity or potency, (2) latency or induction time, (3) penetrance or extension, (4) duration of action, and (5) local and general toxicity With these points in mind, a few brief remarks concerning each of the most common local anesthetic drugs will be made and a table included

Procaine

For almost fifty years procaine has been considered the local anesthetic drug which nearest approaches the ideal However, extensive clinical studies and use of this and other drugs have shown this drug to possess a number of serious deficiencies The most important of these are its comparatively short action (1-1½ hours) and slightly greater toxicity than Pontocaine chloroprocaine and other drugs Although its latency time is relatively short, drugs such as chloroprocaine, Xylocaine, and Cyclaine produce more rapid effects

The concentration and doses of procaine and other drugs is indicated in Tables II (page 76), V (page 253) and VII (page 260)

Nesacaine (2 Chloroprocaine)

Nesacaine* is a relatively new local anesthetic drug

paravertebral somatic or sympathetic blocks To obviate this effect, it is recommended that one third to one-quarter of the volumes usually recommended be employed The other disadvantages concern its toxicity Contrary to the initial reports (which suggested that this drug in equal doses is no more toxic than procaine), clinical study and experience have shown that in actuality it is twice as toxic as the standard drug For this reason it is strongly recommended that the maximum amount of Xylocaine used at any one time be limited to 500 mgm

In our practice Xylocaine is frequently mixed with Pontocaine or Nupercaine to obtain the advantage of the rapid onset of action exerted by Xylocaine and the prolonged effect afforded by Pontocaine or Nupercaine For example, paravertebral blocks of the somatic or sympathetic nerves are frequently carried out with a solution containing 1% Xylocaine and 0 075% Pontocaine This is obtained by mixing equal volumes of 2% Xylocaine and 0 15% Pontocaine It is of course important to realize that such a combination makes it mandatory that the total dose of each of these drugs is reduced to approximately one half that usually recommended when these drugs are employed alone

Pontocaine (Tetracaine)

Pontocaine is one of the most useful local anesthetic drugs for any form of regional anesthesia Despite the fact that the drug was first synthesized in 1928 and despite the favorable findings of many early laboratory and clinical investigators, the use of this drug for any purpose other than topical and spinal anesthesia has been very limited This has been due to the misconcep-

TABLE II

DOSES OF LOCAL ANESTHETICS FOR NERVE BLOCK

Drug	*Local Infiltration and Field Block*	*Sympathetic and Small Nerve Block*	*Large Nerve and Plexus Block*	*Extradural Block*	*Maximum Amount** *Mg/Kilo*	*Maximum Amount** *Total*
Procaine	0.5%	1%	2%	1–3%	10–15	1000
Nesacaine	0.5%	1%	1.5%–2%	1–3%	10-15	1000
Xylocaine	0.3%–0.5%	0.75%	1%	1–2%	5–7	500
Cyclaine	0.3%–0.5%	0.75%	1%	1–2%	5–7	500
Metycaine	0.5%	1%	2%	1–3%	8–10	750
Intracaine	0.5%	1%	1.5%–2%	1–3%	8–10	750
Pontocaine	0.05%	0.1%	0.15%–0.2%	0.2%–0.3%	1–1.5	100
Nupercaine	0.05%	0.1%	0.15%–0.2%	0.2%–0.3%	0.8–1	75

* These are maximum amounts in the average young adult patient in good physical condition. Many procedures can and should be done with less drug. In cachectic or aged patients the quantity should be decreased by at least one third.

proximately twice that of procaine, Xylocaine next to procaine is the most widely used local anesthetic drug. This popularity is merited and is no doubt due to its superior penetrance which increases markedly the extent of anesthesia and the proportion of successful blocks. It has been found to be the most stable local anesthetic drug presently available, and even strongly alkaline or strongly acid solutions fail to decompose it. Commercially available Xylocaine has a pH of slightly less than 7, is isotonic, causes no hemolysis, local irritation, or any other signs of local toxicity (81).

Two drawbacks inherent in the use of Xylocaine should be mentioned. The superior penetrance, which is a great advantage in most instances, is in others a disadvantage. In nerve block procedures which require that the effect of the block be limited to one or two segments, injection of volumes usually recommended produce such an extensive effect as to make the procedure useless, especially in diagnostic and prognostic

block) the new drug produces a block which is more rapid in onset and lasts two to three times as long as that produced by the standard drug Moreover, toxic reactions, when equitherapeutic doses are used are less with Cyclaine In addition, it has superior penetrance which parallels those of Xylocaine and Nesacaine, respectively The only significant disadvantage is that it occasionally produces burning on injection

Clinical evaluation of Cyclaine with Xylocaine in the same concentration reveals that the latency or induction time is slightly longer with Cyclaine than with Xylocaine, the potency of the two drugs is approximately the same, and that Cyclaine offers a slightly longer duration of action and produces slightly less general toxicity than Xylocaine (80) The anesthesia is not as profound with Cyclaine as that produced by Xylocaine, nor does it possess the penetrance or the diffusibility of Xylocaine but is a very close second in this respect

The recommended dosage of Cyclaine is shown in Tables II (page 76), III (page 81), V (page 253), and VII (page 260)

Metycaine (Piperocaine)

Metycaine is a useful and safe local anesthetic drug which may be used for all types of regional anesthetic procedures Metycaine produces slightly more prompt, more intense, and longer anesthesia than procaine, and therefore can be given an anesthetic index greater than one Its toxicity is slightly greater than procaine, but because of its greater potency it may be employed in three-quarters of the dose of procaine

Comparison of Metycaine with Xylocaine indicates that the potency of Metycaine is approximately two

tion that exists widely among many clinicians in this country that Pontocaine is too toxic to use for regional anesthesia other than spinal or topical

A review of the literature and an analysis of over 6,000 cases carried out in our various departments revealed the potency of Pontocaine to be 12 to 15 times that of procaine and its toxicity eight to ten times that of the standard drug (82) These data suggest that the correct toxicity ratio of Pontocaine is 0 6 and its anesthetic index is 1 8 In other words, by using Pontocaine in concentrations 1/10 to 1/15 that of procaine, the drug *is less toxic* than the standard Moreover, it produces blocks which are of markedly greater duration In concentrations ranging from 0 05 to 0 25%, Pontocaine with epinephrine produces blocks which last four to six or seven hours compared with those of one to two hours produced by equivalent concentrations (0 5-3%) of procaine For this reason I consider Pontocaine the local anesthetic drug of choice when it is desirable to have prolonged blocks and when the patient's physical condition requires a drug with low toxicity It should be stressed that for blocks other than subarachnoid Pontocaine should never be used in concentrations higher than 0 25%, and that the total dose should not exceed 1 mgm per pound of body weight

The recommended dosage of Pontocaine is indicated in Tables II (page 76), III (page 81), V (page 253), and VII (Page 260)

Cyclaine (Hexylcaine)

Cyclaine is a relatively new drug which has been found to be twice to three times as potent and twice as toxic as procaine In equiactive concentrations (e g , 1% Cyclaine and 2% procaine for brachial plexus

Intracaine

Intracaine acts more promptly, more intensely, and for longer duration than procaine, and in addition it is a good surface anesthetic. Its relative toxicity has been found to be 1.42 times as great as that of procaine, but because of its greater anesthetic potency it can be used in one-half to two-thirds the dose of procaine with equal effectiveness.

The recommended dosage of Intracaine is shown in Tables II (page 76), III, V (page 253), and VII (page 260).

TABLE III
DOSES OF LOCAL ANESTHETICS FOR TOPICAL APPLICATION

Agent	*Concentrations*	*Maximum Dose*
Pontocaine or Nupercaine	0.5-2%	50 mg
Xylocaine or Cyclaine	2-5%	200 mg
Intracaine, Metycaine	4-10%	350 mg
Cocaine	4-10%	200 mg

Epinephrine and Other Vasoconstrictors

Vasoconstrictor drugs potentiate the action of local anesthetic agents by producing a local vasoconstriction which greatly decreases the blood flow and thereby retards the absorption of the local anesthetic agent. This, in turn, has the following beneficial effects: (1) it permits the local anesthetic to remain in actual contact with the nerve tissues for a longer period of time and thus prolongs the duration of the block; (2) it increases the relative potency of the local anesthetic drug and thus increases the intensity or pro

thirds that of Xylocaine, the onset of block is con siderably slower and the duration of anesthesia shorter with Metycaine, and the penetrance of Metycaine is significantly less while its toxicity is about two thirds that of Xylocaine

The recommended dosage of Metycaine is shown in Tables II (page 76), III (page 81), V (page 253), and VII (page 260)

Nupercaine (Dibucaine)

Despite laboratory evidence to the contrary, Nupercaine, when properly administered, is one of the most useful local anesthetic drugs available at the present time Its outstanding advantage is that it furnishes an impressively longer duration of block than any other local anesthetic agent

Nupercaine has an absolute toxicity fifteen times as great as procaine but is at least twenty times as potent as the standard drug, so that the anesthetic index is 1 33 In equitoxic concentrations (e g , 0 1% Nuper caine and 1 5% procaine) Nupercaine produces an esthesia which is slightly more profound and three to five times longer than that of the standard drug The great disadvantage of Nupercaine is its very long induction period, being two to three times that of pro caine and five to six times that of Xylocaine If this fact is taken into consideration, Nupercaine may be used to great advantage in diagnostic and therapeutic nerve blocks in order to produce prolonged interrup tion

The recommended dosage of Nupercaine is shown in Tables II (page 76), III (page 81), V (page 253), and VII (page 260)

inaccurately by the drop method To facilitate the determination of the exact amount needed to add to a local anesthetic drug, it is suggested that a 0 25 ml tuberculin syringe be employed to measure the vasoconstrictor A good basic rule for this purpose is to use 0 1 ml of 1 1000 (0 1 mgm) epinephrine for each 20 ml of local anesthetic solution, or to employ 0 25 ml of the epinephrine for each 50 ml of local anesthetic solution

Although many other drugs, including Cobefrin (Corbasil), Neosynephrine, and Ephedrine have been advocated and used, they are not as effective as Epinephrine Some newer vasoconstrictor agents, particularly 1 nor-adrenalin show more promise since they produce the same degree of local vasoconstriction, but with less generalized side effects

Hyaluronidase

During the past decade hyaluronidase, the so-called 'spreading factor," has been advocated and used to facilitate the spread of local anesthetic solution in the hope of increasing the number of successful nerve blocks, to hasten the onset of anesthesia, and also to increase the area of block Although it does hasten the onset of infiltration of topical and extradural anesthesia, it does not consistently increase the number of successful nerve blocks as had been hoped As might be expected, the wider spread of the local anesthetic solution increases its absorption and thus shortens the duration of anesthesia and augments the incidence of toxic reaction These disadvantages together with the clinical use of new local anesthetic drugs with marked penetrance have discouraged the use of hyaluronidase

foundness of the block while at the same time it de creases slightly the induction (latency) time,* (3) it permits the use of smaller concentrations of local anes thetic agents, and (4) the decrease in absorption permits the rate at which the anesthetic is destroyed to keep pace with the rate at which it enters the circulation, thus reducing the danger of toxic reactions ʻ Moreover, the vasoconstrictor drug counteracts the de pressing effects of the local anesthetic on the myocardium and vascular system Because of these effects, it should be used in almost all instances but is especially indicated in patients who are poor risk The only con traindication to vasoconstrictor drugs are (1) Peripheral vascular diseases when the block is being done for diagnostic purposes to ascertain the degree of vaso spasm, (2) Hyperthyroidism, (3) Patients who are extremely apprehensive and for whom large amounts of local anesthetic drugs are necessary, (4) Patients with severe cardiac disease, especially when it is accompanied by tachycardia

The optimum concentration of epinephrine for this purpose is 1 200,000 A lower concentration is not as effective, while a greater concentration produces a high incidence of undesirable side effects, (see page 95) Moreover, concentrations greater than 1 200,000 actually decreased the duration of the block, prob ably by producing such a marked vasoconstriction as to effect a local acidosis, which, in turn, prevents hydrolysis of the salt and liberation of the base, and also may delay healing or result in necrosis

One of the most frequent and grievous errors in regional anesthetic practice is to measure the amount of epinephrine or other vasoconstrictor crudely and

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These somewhat paradoxical phenomena are explained elsewhere (83)

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Oil Solutions and Other Suspensions of Local Anesthetics

In an attempt to prolong the effects of local anesthetic agents to control postoperative and chronic pain, numerous artifices of dissolving or suspending local anesthetic bases in oils of various kinds and in other media have been proposed and given clinical trial These include Novestoil (Novocal Chem Mfg Co), Nupercaine in oil (Ciba), Intracaine in oil (Squibb), Xylocaine (Abbott) and Eucupine in oil (Rare Chemical) The aim of these preparations was to achieve a slow gradual release of the active base, resulting in continuous block of the nerve fibers in the injected region Despite this intriguing hypothesis and the claims of favorable results published by some of the earlier enthusiastic writers, the use of these preparations has never been widespread, and at the present time they have a dubious place in clinical medicine Most clinicians have found that these preparations provide erratic and unpredictable results This lack of uniformity of action, together with a not infrequent occurrence of ecchymosis swelling, abscess formation, sloughing of the skin, and prolonged tenderness of the injected site, has caused most clinicians to abandon the use of oily solutions

These preparations may be used with some success in blocking local infiltration of trigger areas and small nerves, provided that such a block can be completed with very small volumes In addition they may be effective in producing block of the sacral nerves following injection of appropriate volumes into the sacral canal, which may act as a depot for prolonged bathing of nerve fibers On the other hand, since the oil

constitutes more of a barrier than an aid, it might be more effective to inject benzyl alcohol alone My experience with these preparations prompts me to not recommend them for clinical use The same comment is made about Eucupin Procaine

Efocaine

Efocaine is a specially balanced solution of procaine and butyl amino benzoate in an organic solvent that is miscible with body fluids in all proportions The solution is at saturation limits, so that the addition of even minimal quantities of water or body fluids causes a complete and immediate precipitation of the active ingredients at the site of injection, a mechanism of action not dissimilar from that of suspensions of estro gens and of procaine penicillin

Despite preliminary enthusiastic reports this drug has been abandoned because while effective in producing a block for several days, its use is followed by a high incidence of postinjection neuropathy with neuralgia Moreover, a number of cases of transverse myelitis with consequent paraplegia have been re ported (84) This extremely serious complication, which probably results from intraneural injection of the glycol and its subsequent centrifugal diffusion to the spinal cord, emphasizes to a marked degree the im portance of proper technic, and the avoidance of in jections of this drug near the spinal canal

This drug may be employed to produce a block of several days' duration provided (1) that only small quantities, 1 ml per nerve, be injected, (2) that the solution be deposited in the immediate vicinity of the nerve, an operation that can only be accomplished by

direct vision during the operation or by eliciting paresthesia, and (3) that the drug be considered as a neurolytic agent which causes lasting local anesthetic effects by destruction of nerves Its routine use is to be deplored, and the drug should be reserved for very selected patients in whom a prolonged block is necessary, even at the risk of serious complication

Ammonium Compounds

Ammonium compounds of various combinations and strengths have been used on the premise that these drugs interrupt amyelinated or thinly myelinated fibers of somatic nerves and thus eliminate certain types of pain without interfering with other sensations (39) This selective action on the pain fibers is said to last much longer than that with local anesthetic drugs Unfortunately clinical studies have revealed that these agents produce blocks which lack uniformity of action More recently compounds containing greater concentrations of ammonium sulphate, benzyl alcohol, and procaine base have been tried and have produced better results, particularly when used to produce sympathetic blocks and when injected into the extradural space (85) However, I have noted signs of postinjection neuropathy consisting of hyperalgesia and pain in a significant proportion of patients, especially when the block has involved a somatic nerve These results have led me to suspect that these compounds produce prolonged block as a result of degenerative action by the benzyl alcohol and perhaps the ammonium sulphate, and that they must therefore be considered as neurolytic agents which produce complications less severe than alcohol

Neurolytic Agents

The injection of neurolytic agents to interrupt nervous pathways for a prolonged period of time has been practiced for many years The object of such injection is to destroy the nerve fibers and thus produce a prolonged and sometimes permanent nerve block with resultant effects simulating those of nerve sections These procedures are reserved for patients with chronic disorders in whom neurosurgery is contraindicated either because they are in poor physical condition or for other reasons The most commonly employed agents in this group include ethyl alcohol, benzyl alcohol, and phenol

Ethyl Alcohol

Despite its drawbacks, ethyl alcohol remains the most useful and effective agent for the production of prolonged block When properly employed, it effects interruption for periods varying from a few months to several years, and if the injection involves nerve cells, the effects are permanent This action is produced with surprisingly little deleterious effect upon contiguous tissue, but unfortunately a relatively high per cent of patients develop signs and symptoms of the postinjection neuropathy

Concentrations of alcohol 40 to 50% or less affect non myelinated and thinly myelinated fibers, including those which convey pain, sudomotor, and vasomotor impulses without significantly affecting large fibers or those which are heavily myelinated conveying skeletal motor touch pressure and proprioceptive impulses On the other hand alcohol injection of sympathetic ganglia or sensory nerve ganglia produces a permanent block apparently due to the destruction of nerve cell

bodies, which of course do not have the power to regenerate

These findings have obvious clinical implications For one thing, injections of alcohol must be exceedingly accurate in order to produce the desired effects and at the same time avoid complications If the block is intended to produce very prolonged or permanent effects, it is essential to inject the alcohol into or near to sensory or autonomic ganglion In order to obtain uniform and complete interruption for somatic nerve block, it is best to inject the solution into the nerve since alcohol diffuses very poorly due to coagulating effects of nerve tissue

The frequency and severity of so-called postinjection alcoholic neuritis make it almost mandatory to reserve the use of this agent for patients with severe, intractable pain in whom other measures cannot be employed This is especially important in block of peripheral somatic nerves It is also important in paravertebral block of sympathetic pathways in the thoracic regions where the sympathetic trunk lies so close to the somatic nerves that the alcohol intended for the ganglia frequently spills and partially destroys somatic fibers It is the degenerative regenerative process of sensory nerves which produces hyperesthesia, burning pain, with occasional bouts of sharp shooting pain These symptoms occur in over half of the patients who have alcohol blocks of peripheral somatic nerves Fortunately the majority of patients experience only mild symptoms which disappear within a few days or weeks However, sometimes the symptoms are so severe as to be worse than the original problem and thus obscure any therapeutic benefit of the block In some of these instances, it may be necessary to perform a

rhizotomy or chordotomy in order to provide relief from pain. On the other hand, injection of alcohol into the subarachnoid space or the gasserian ganglion or into autonomic (sympathetic) nerves which are not accompanied by sensory nerves is rarely followed by this complication, probably because there is no regeneration.

Benzyl Alcohol

In 10% concentration this agent will destroy all the fibers of small nerves, and in 5% concentration will destroy a considerable number of them. Contrary to the claims of some writers, manifestations of postinjection neuropathy are seen after the use of this agent, but fortunately the signs and symptoms are usually mild. In order to minimize this complication, it is suggested that concentration of 5% or lower be employed.

Phenol

During the last decade, numerous clinicians have reported the use of 6 to 10% aqueous solutions of phenol to produce prolonged sympathetic block or as sometimes referred to "chemical sympathectomy" (86, 87, 88). I have been impressed with the results obtained in our clinic.

There are two notable drawbacks to the use of phenol: (1) the duration of the effect is remarkably variable, ranging from several days to as long as nine months, and (2) in spite of the great care observed in the proper placement of the needles, postinjection neuropathy manifested by burning pain and mild hyperesthesia has occurred in a considerable number of our patients. Obviously the use of phenol is not with-

out danger of some complications, nonetheless I recommend it for the production of prolonged sympathetic blocks in volumes of 3 to 10 ml for each block

Miscellaneous Group

Saline and Water

Saline has been employed with good results by many clinicians (92) to inject trigger areas in the treatment of myofascial syndrome The methods by which these are brought about are not entirely understood It has been suggested that the pressure of the injected solution into the trigger area interrupts the feeding of noxious impulses from the focus of irritation to the spinal cord and thus breaks up the so-called vicious circle

The injection of saline into the sacral canal and epidural spaces has also been employed in the treatment of post-spinal headaches and also in that of certain types of lumbosacral neuralgia and postoperative and post-traumatic low back pain The beneficial effect in these conditions is due to the increase in the extradural pressure, which is reflected in the subarachnoid space The injection of saline into a major nerve or into a neuroma in patients suffering with phantom limb pain has also been used

Water has been used in a similar way More recently the injection of boiling water into the gasserian ganglion to produce prolonged relief of pain in patients with trigeminal neuralgia and cancer has been reported and advocated (89) The results obtained in three cases in our clinic indicate that this method shows promise

Corticoids

The injection of hydrocortone and other corticoids into joints, periarticular structures, bursae, and other myofascial structures has proven to be a very effective adjunct in the management of certain types of arthritis and other musculoskeletal disorders The mechanism by which these agents effect relief of pain, diminution of edema, and other manifestations of inflammation and increase in function is not entirely clear Nonetheless, this method is one of the most important conservative measures employed in these conditions

Topical Agents

The topical application of local anesthetic agents is one of the most effective means of managing certain painful disorders of mucous membrane The concentrations and amounts of these drugs are indicated in Table III

Ethyl Chloride has been used successfully by many clinicians as a spray in the treatment of certain myofascial pain syndromes and of other disorders which are caused and maintained by trigger areas in the superficial tissue

The mechanism by which beneficial effects are ob tained is not entirely clear, but it has been suggested that the ethyl chloride like saline injection blocks noxious impulses or interferes in some other way with the trigger area and prevents it from constantly feeding noxious impulses into the spinal cord, thus breaking up the vicious circle

For optimum results, it is important to apply this spray about twelve to twenty four inches above the skin

surface in the area of the trigger region and to move slowly in one direction rather than to and fro, as shown in Figure 10b (page 120) The sweep should be started at trigger areas and made to travel toward the reference zone

CHAPTER VII

COMPLICATIONS OF NERVE BLOCKS

THE IMPORTANCE OF avoiding complications which can occur during and following nerve blocks has been duly stressed in preceding pages It needs to be re-emphasized that no physician should attempt any regional anesthetic procedure without having a thorough knowledge of the possible complications that may occur, the requisites for their prevention, and expert ability to recognize and treat them immediately when they do occur *No nerve block procedure should ever be attempted regardless of its simplicity without having equipment to treat complications, immediately available* Before each of these procedures is attempted, the equipment should be checked to be certain that it functions properly and that all the possible pieces of equipment are immediately available It is with this in mind that the following brief discussion of the most frequent complications that occur during or following nerve block is presented For a more detailed exposition of the subject, the reader is referred to Moore's excellent work *Complications of Regional Anesthesia* (84) and my own text (49)

Alterations in Blood Pressure

Hypotension

Hypotension is a frequent complication of extensive subarachnoid, epidural, paravertebral, or prevertebral blocks because these entail interruption of many of the vasomotor segments which contribute to the splanchnic area This complication is more likely to occur in patients who have essential hypertension, arteriosclerosis, or other cardiovascular diseases which limit the effectiveness of homeostatic responses Unless the purpose of the block contraindicates it, it is advisable to administer a prophylactic dose of vasopressor to obviate peripheral vasodilatation

Active treatment of hypotension consists of the intravenous injection of small doses of vasopressors (15 to 25 mg of ephedrine, 1 to 3 mg of Vasoxyl, ½ to 1 mg of Neosynephrine, or equiactive doses of other vasopressors), followed by a larger intramuscular dose (25 mg Ephedrine, 10 mg of Vasoxyl, or equiactive dose of other vasopressors) The administration of oxygen and the use of the Trendelenberg position to facilitate circulation to the brain and heart, and in some instances, the use of intravenous fluids may be indicated as auxiliary therapeutic aids

Patients who develop hypotension following alcohol block of the splanchnic nerves of the celiac ganglia are very difficult to manage since they frequently experience orthostatic hypotension which may last for several months The use of abdominal binder, the taking of vasopressors by mouth, and the avoidance of sudden movements, especially in assuming the standing or sitting position from recumbency, may prove effective in lessening the degree of hypotension

Hypotension may occur as a manifestation of systemic reaction due to the toxic effects of local anesthetic drugs, but since the symptomatology and treatment of these reactions will be considered subsequently, nothing more will be said here except to emphasize the importance of treating the hypotension in the manner described above

Hypertension

An increase in blood pressure may occur as a result of a toxic reaction to the local anesthetic agents or to the epinephrine In either case it is usually due to improper technic, or overdosage, or both, and is avoidable When it occurs, it requires symptomatic treatment consisting of intravenous barbiturates, in order to allay the usual apprehension and to produce a slight decrease in blood pressure If the blood pressure is sufficiently high, it may be necessary to use amylnitrite pearls for temporary relief or to give a hypotensive drug such as hexamethonium or Arfonad, until the hypertension has disappeared

Systemic Reactions to Local Anesthetic Drugs

Toxic reactions to local anesthetic drugs are usually due to injection of an overdose or to improper technic or to both This results in mixed effects which involve the cardiovascular, respiratory and central nervous systems These reactions may be arbitrarily subdivided into three types according to the degree of severity mild, moderate, and severe

A mild toxic reaction occurs when the level of the systemic circulation is just above physiologic limits,

causing the patient to experience light headedness, vertigo, tinnitus, headache, apprehension, excitement, tachycardia, slight hypertension, tachypnea, a metalic taste and dryness of the mouth and throat, occasionally nausea, and sometimes slight twitching of muscle groups Mild reaction seldom requires treatment beyond close observation and encouragement of the patient and the occasional use of small amounts (50 to 100 mg) of Pentothal or Surital intravenously

Moderate toxic reactions are caused by greater concentration of local anesthetic drugs in the systemic circulation and are characterized by a progressive aggravation of the above signs and symptoms The patient usually becomes confused or sleepy, sometimes loses consciousness, develops muscular twitching which usually progresses to convulsions, and the blood pressure and pulse rise rapidly Since convulsions interfere with proper ventilation, the patient develops cyanosis and other signs of anoxia Such reactions require immediate active treatment, which is directed at the prevention of anoxia and elimination of the central nervous system stimulation This entails the administration of oxygen and the intravenous injection of a rapid acting muscle relaxant such as succinyl choline Usually 20 to 30 mg of this drug eliminate the muscle hyperactivity and permit adequate ventilation of the patient Heretofore, ultra short acting barbiturates, such as Pentothal and Surital, have been used and advocated for this purpose Since the advent of muscle relaxants, however, the use of barbiturates has been discouraged on the grounds that, since toxic concentration of the local drug produces a concomitant myocardial depression, which is of course masked by the skeletal muscle stimulation, intravenous adminis

tration of barbiturates, except in very small doses, will aggravate the myocardial depression to the point of causing rapid failure

Severe toxic reactions are usually due to a massive over-dosage of the local anesthetic drug They are manifested by loss of consciousness, coma, severe hypotension and bradycardia, respiratory depression which may end in paralysis, and other signs of severe central nervous system, cardiovascular, and respiratory depression If immediate treatment is not instituted, the condition may become grave, with consequent complete respiratory and cardiovascular failure and death Fortunately, in most instances respiration fails before circulation Treatment of severe toxic reaction consists of the support of the respiration and circulation by means of assisted or controlled ventilation with oxygen, intravenous administration of vasopressor drugs and the placing of the patient in Trendelenburg position An infusion should be started immediately to provide an avenue for intravenous administration of whatever drugs are necessary In the event that the usual vasopressors are ineffective, it is advisable to administer Neosynephrine, or better still, nor epinephrine in dilute solutions (20 mg of Neosynephrine or 4 mg of nor-epinephrine added to 1,000 cc of 5% glucose in water) intravenously In extreme cases, the cardiovascular depression may progress to cardiac arrest which requires immediate thoracotomy, cardiac massage, artificial ventilation, and other measures which will be mentioned subsequently

Other Systemic Reactions of Nerve Blocks

Undesirable reactions to nerve blocks frequently

occur from causes other than overdosage of local anesthetic drugs Perhaps the most frequent of these is the so called *psychogenic reaction* which is caused by apprehension and fear of the block procedure This is usually manifested by dizziness, faintness, occasional ringing in the ears, marked perspiration, tachycardia, and paleness of the skin This frequently occurs as soon as the procedure is initiated, even before any solution is injected Treatment consists of the administration of oxygen, the placing of the patient in the recumbent or Trendelenburg position, and if the hypotension is sufficiently severe, the intravenous administration of vasopressors

Another very common cause of reactions, especially those which occur in the dental chair, is *over dosage of epinephrine* or other vasoconstrictors The patient may experience an extreme degree of palpitation, tachycardia, dizziness, perspiration, and paleness of the skin These patients are treated by the administration of a small dose of a fast acting barbiturate in order to allay apprehension and to reduce the blood pressure to normal limits In the event that the hypertension is severe, it may be necessary to administer a vasodilator such as nitroglycerine amyl nitrite, sodium nitrate, or the more potent ganglionic blocking agents

Allergic reactions to local anesthetic occur in some patients following such repeated exposure as obtains in dentistry and are manifested by generalized urticaria, joint pains, and edema, particularly of the eyelids, hands, joints, and larynx Treatment consists of administration of antihistaminics and/or epinephrine The patient should then be observed closely for severe laryngeal edema, and if this occurs it is strongly advisable to produce a tracheostomy

On very rare occasions the administration of very small amounts of a local anesthetic drug may result in sudden cardiovascular and respiratory collapse, which may be rapidly followed by death Although there is little doubt that such a phenomenon may occur with local anesthetic drugs, the incidence must be extremely rare for I have never seen its occurrence during fifteen years of active regional anesthesia practice Such a reaction must be classified as an *idiosyncrasy*, since it occurs rarely and bears no relation to dosage The treatment is the same as that described for severe toxic reactions and includes artificial ventilation with oxygen, vasopressor drugs, and if necessary cardiac massage Barbiturates *should not* be administered because they aggravate the depression It is difficult to avoid such reactions because they may occur even during the performance of skin tests for sensitivity

This brings up a very important problem Every patient who is to have local anesthetic administered should be interrogated regarding previous reactions If there is any question, an intradermal test should be performed In order for such a test to be reliable, it is necessary to raise several skin wheals on the forearm with enough distance between each to permit reading It is suggested that one wheal be formed with physiologic saline solution, a second with the local anesthetic drug suspected to produce sensitivity, a third wheal with the same local anesthetic drug to which epinephrine has been added, and the fourth with another local anesthetic drug, with a different chemical radical It is, of course, important to use different needles and syringes for each preparation The wheals are examined 15 minutes later when the

areas of redness produced by the drugs are compared to those produced with the saline Sensitivity should be suspected only if a very large area of redness surrounds the wheal

Pneumothorax

Pneumothorax is a complication which may occur following thoracic paravertebral injections, intercostal block, brachial block by the supraclavicular route, and stellate ganglion block The incidence of this complication is particularly high with thoracic paravertebral block, even when these procedures are carried out by experienced physicians This is due to the fact that the pleura hugs the thoracic cage closely, particularly in the paravertebral cavity or trough, where there is very close contact with the endothoracic fascia In its advance to the lateral surface of the body of the vertebra the needle may easily pass throuph the pleura and lung, causing a small bronchopleural fistula Con trary to common belief the pneumothorax is not the result of aspiration of air from the outside through the needle caused by the negative pressure into the pleural spaces, but rather it is consequent to the aspiration of air from the alveoli through the small bronchopleural fistula crated by the needle Therefore, the use of stylets or the attachment of small syringes in order to prevent the aspiration of air from the outside into the pleural space are of little, if any, value in preventing this complication

Any patient who has received one of these blocks and complains of chest pain or dyspnea or both deserves a physical and roentgenographic examination of the chest to confirm the diagnosis and to ascertain the degree of collapse

Treatment of mild cases consists of reassuring the patient and advising him to abstain from activity Occasionally analgesics are necessary for relief of the pain In the unusual case in which the patient manifests moderate to severe respiratory dysfunction, it may be necessary to aspirate the air from the pleural space, to administer oxygen, and to give analgesics

Inadvertent Subarachnoid (Spinal) Block

The accidental injection of local anesthetic drugs into the subarachnoid space is a complication which may occur during paravertebral or peridural block In the former case it may be due to accidental invasion of the spinal canal by a needle inadvertently advanced through the intervertebral foramen, or it may be due to inadvertent injection of solution into an abnormal prolongation of the meningeal cuff projecting beyond the intervertebral foramen Its occurrence during caudal block is the result of advancement of the needle too far cephalad, or the presence of an abnormally long dural sac Unless extreme care is exercised in performing a spinal epidural block, perforation of the dura will occur all too frequently

Its prophylaxis requires a careful technic, observation of the hub of the needle for 15 to 30 seconds for the appearance of cerebrospinal fluid, and the frequent performance of the aspiration tests before and after the injection of a small amount of air to dislodge a veil of arachnoid which may be against the bevel of the needle Since the total amount of local anesthetic drugs used for these procedures is three to five times that used for subarachnoid block, it is apparent that should such an accident occur, the patient will develop a very high or total anesthesia

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Treatment of this complication consists of (1) immediate performance of artificial ventilation, (2) the simultaneous withdrawal of as much spinal fluid as possible, and (3) support of the circulation by means of intravascular fluids and vasopressors If the patient develops respiratory weakness or paralysis, it is advisable to insert an endotracheal tube and connect it to the resuscitative apparatus to facilitate ventilation

Inadvertent injection of a local anesthetic drug into the cerebral subarachnoid space may occur during injections of cranial nerves, particularly the gasserian ganglion This usually results in sudden loss of consciousness and respiratory paralysis It can and should be avoided by proper technic and frequent aspirations to ascertain that the point of the needle is not within the subarachnoid space

Hematoma

Bleeding into the site of injection is one of the most common complications of this form of therapy Although in many instances this is of a minimal degree, it may become serious in patients who have blood dyscrasias or have been on anticoagulant therapy

Hemorrhage can be prevented or minimized by using fine, sharp needles and proper technic, and by using pressure after the injection has been completed, particularly if it involved the face Nerve blocks should be used with caution or not at all in patients receiving anticoagulant therapy, or in those who have a blood dyscrasia or a prolonged bleeding time Treatment consists of cold packs and pressure over the site of bleeding, transfusion if the patient has lost sufficient blood, and anticoagulant therapy

Post-injection Neuropathy

Sensory, motor, or autonomic disturbances rarely occur following nerve blocks with local anesthetic drugs These are probably due to damage to the nerve by the point of the needle, to intraneural injection, or to both, and suggest improper technic The rare neurologic sequela which follows spinal anesthesia may be due to contamination of the local anesthetic drugs with antiseptic solution or other chemicals during sterilization or during the performance of the block

All of these complications can and should be avoided by exercising care in the preparation of the equipment and in the performance of the block *It should be stressed that all equipment and drugs which are to be used for any form of regional anesthesia or nerve blocks should be sterilized by autoclaving and not by immersing in antiseptic solution*

The treatment of these sequelae is a neurologic problem and a detailed discussion of it is beyond the scope of this monograph

Respiratory Dysfunction and Paralysis

Disturbances of respiratory function may result from depression of the respiratory center, from peripheral respiratory muscular paresis or paralysis or from both The depression of the respiratory center may result from severe systemic reaction to local anesthetic drugs, from overdosage from massive subarachnoid injection, or from anoxia consequent to a block procedure Weakness or paralysis of the respiratory muscles may be the result of extensive subarachnoid, epidural, paravertebral, or intercostal block

Treatment of this complication consists of (1) immediate performance of artificial ventilation, (2) the simultaneous withdrawal of as much spinal fluid as possible, and (3) support of the circulation by means of intravascular fluids and vasopressors If the patient develops respiratory weakness or paralysis, it is advisable to insert an endotracheal tube and connect it to the resuscitative apparatus to facilitate ventilation

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Regardless of the cause, the signs and symptoms are the same and are manifestations of anoxia which must be relieved by immediate therapy. This consists of controlled ventilation with 100% oxygen. In patients who are in apnea, ventilation is best accomplished by introducing an endotracheal tube and connecting it to a resuscitative apparatus. Since this complication may occur during or following any block procedure, the importance of having resuscitative equipment in good functioning order and available for immediate use is apparent. *A physician should never attempt nerve block procedures without having such equipment ready for use. Moreover, he should be skilled in performing laryngoscopy, endotracheal intubation and artificial ventilation.*

In order to properly ventilate the patient, it is essential that the anatomic airway be patent. Should the physician commit the grievous error of performing such a procedure without adequate resuscitative measures and should the patient require artificial respiration, mouth to mouth breathing may be used.

Cardiac Arrest

This terrifying and often catastrophic complication is fortunately relatively rare during and following nerve block procedures (49, 84). On the other hand, since it can occur, the physician who performs diagnostic and therapeutic blocks must be constantly aware of this impending danger, so that he may recognize and treat it immediately. For unless he does so the patient will die.

The etiologic factors which may play a part in the causation of cardiac arrest during or immediately after

PART II

CLINICAL CONSIDERATIONS

manual compression of the heart (cardiac massage) at a rate of 50 to 60 per minute performed through an opening in the chest A thoracotomy is executed by making an incision through the 4th or 5th interspace from the posterior axillary line to two inches lateral to the sternum, and section of the costal cartilages above and below The ribs are forcibly spread apart, and the heart is grasped between the two hands and forcibly compressed When properly executed, cardiac massage raises the systolic arterial pressure to 50 to 70 mm of mercury The use of 5 to 10 degree Trendelenburg position and the compression of the aorta may enhance cerebral and coronary circulation

The reestablishment of cardiac and respiratory activity often occurs spontaneously without the aid of drugs if the initial parts of the treatment have been accomplished immediately If the heart is in standstill and lacks tone, the injection of 0 1 to 0 2 mg of epinephrine into the left ventricle and then compression of the heart so that the cardiotonic drug is made to circulate through the coronaries is usually effective This may be repeated at five to seven minute intervals In case of fibrillation, it may be necessary to defibrillate the heart by means of passing an electric current of 130 volts at a standard of 1 5 amperes for a period of 0 1 to 0 2 seconds The shock is repeated between intervals of cardiac massage until defibrillation is effective

CHAPTER VIII

LOCAL BLOCK

(Infiltration and Topical Application)

LOCAL INFILTRATION and topical application of anesthetic agents is, without doubt, the most frequently employed technic of analgesic block in the treatment of pain Simplicity, facility and apparent innocuousness make this the method of choice among many physicians, particularly those who are not familiar with more complex nerve block technics By producing physicochemical interruption of nervous pathways almost at the very source of the physiopathologic process, it effectively relieves the symptomatology of many disorders, including myofascial pain syndromes, sprains and strains, tendinitis, epicondylitis, periarthritis, muscular contusions, scalenus anticus syndrome, simple fractures, among many other conditions

Myofascial Pain Syndromes

The most productive clinical application of local block therapy is in the management of myofascial pain syndromes This is a group of disorders characterized by the presence of a ' trigger area" in one of the muscles or in connective tissue, together with a specific syndrome of pain muscle spasm, tenderness, stiffness,

may be defined as small, circumscribed, hypersensitive regions from which impulses arise and bombard the central nervous system to produce referred pain The trigger area is so-called because its stimulation, like the pulling of the trigger of a gun, produces effects at another place (the target), called the "reference zone" or 'area of reference' This term, then, implies the existence of a relationship between two different topographical areas the trigger and the target Perhaps the most important characteristic of the trigger area from a therapeutic standpoint is that, by local block procedures with only transitory pharmacological action, it can be rendered nonexcitable, and the vicious cycle can be terminated for long periods of time or even permanently

Trigger areas may be also initiated by repeated microtraumata of daily living, chronic muscular strain, the chilling of fatigued muscles arthritis, acute myositis, nerve injuries, and other neuromusculoskeletal disorders and by visceral ischemia or dyskinesia These abnormal foci of pain can be activated by pressure, by motion that stretches the structure containing them, by intense heat or cold, diathermy, and prolonged cooling as occurs in damp weather or after being in drafts

Frequently more than one of these trigger areas are found in pain syndromes each having a site of reference comprising a portion of the pain pattern A prolonged barrage of noxious impulses from a trigger area is conducive to the creation of secondary tender areas in the zone of reference In such instances the more recent secondary foci may be a major source of pain, and it is not until these are blocked that the primary focus becomes evident Although trigger areas

limitation of motion, weakness, and occasionally autonomic dysfunction in an area of reference which is usually at some distance from the trigger point These disturbances have been previously described as, among other terms, myalgia, myositis, fibrositis, fibromyositis (or myofibrositis), fascitis, myofascitis, muscular rheumatism, and muscular strains

These disorders are given prominence here because their management constitutes one of the most important problems in clinical practice (30) In fact they are the most common musculoskeletal disabilities of the shoulder girdle, neck, and low back, and certainly are among the most frequent causes of severe disabling pains (13, 49, 78, 90, 91, 92) Moreover, because of their peculiar symptomatology, until recently their true nature was not generally recognized, and consequently they were often misdiagnosed and wrongly treated as bursitis, arthritis, and occasionally as visceral diseases A very significant consideration, which makes this group of disorders particularly important to the general practitioner, is that they are relatively simple to manage, since most of the therapeutic procedures can be carried out in the physician's office and, when treatment is properly executed, prompt cure ensues On the other hand, if therapy is incorrect chronic disability results

Etiology

The most important cause of myofascial pain syndromes are sudden traumata to myofascial structures After acute injury to muscles, bones, and joints in some individuals, there are formed trigger areas"* which

*This term as used here is synonymous with trigger zones trigger points myalgic spots and myalgic areas

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may develop in any muscle, viscera, or connective tissue anywhere in the body, they occur most frequently at sites of greatest mechanical stress. Consequently myofascial pain syndromes occur most frequently in the shoulder girdle, low back, and neck.

Symptomatology

Stimulation of trigger areas produces pain, tenderness, and muscle spasm in the area of reference with consequent limitation of motion and weakness. Frequently these are accompanied by signs of sympathetic dysfunction such as vasospasm and cyanosis, hyperhidrosis and cutis anserina.

The referred pain is dull and aching in character, and its intensity may vary from a low grade discomfort to a type of pain which is very severe and incapacitating. It is usually elicited explosively and spontaneously as soon as the trigger area is stimulated. The extent of the area of the referred pain (and associated phenomena) apparently depends on the sensitivity of the trigger area: the more sensitive the trigger, the greater, the wider, the area involved.

The pattern of this referred pain and associated phenomena is relatively constant and predictable, a fact which indicates that impulses concerned in the unfamiliar reference of somatic pain, like that of visceral pain, follow fixed anatomic pathways. This predictability of pain patterns enables one to use a known reference pattern by which to locate the myofascial source of the pain. It must be added, however, that the distribution of referred somatic pain, though remarkably constant for the structure stimulated, does not follow a dermatomal pattern or nerve root distri-

bution This lack of neurotomal distribution of the symptomatology has been perhaps the most important factor which has delayed recognition of this group of disorders as clinical entities and has misled some physicians to misdiagnose them as bursitis, tendinitis, arthritis, and others to discount their existence and to label them functional

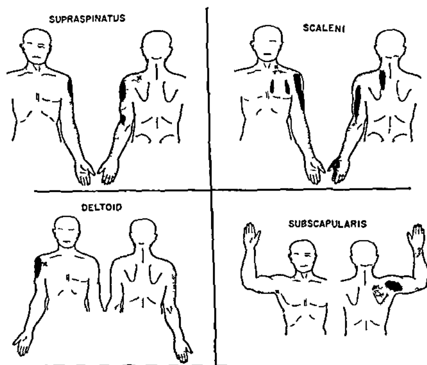


FIGURE 5 Myofascial pain syndromes of the shoulder and arm The mark X" indicates the location of the trigger areas The black area the essential zone and the stippled area the spill over zone (From Travell Courtesy *Postgraduate Medicine*)

The most common myofascial pain syndromes are illustrated in figures 5, 6, 7, 8, 9 These figures represent composite patterns found in patients examined in

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The pattern of this referred pain and associated phenomena is relatively constant and predictable, a fact which indicates that impulses concerned in the unfamiliar reference of somatic pain, like that of visceral pain, follow fixed anatomic pathways This predictability of pain patterns enables one to use a known reference pattern by which to locate the myofascial source of the pain It must be added, however, that the distribution of referred somatic pain, though remarkably constant for the structure stimulated, does not follow a dermatomal pattern or nerve root distri-

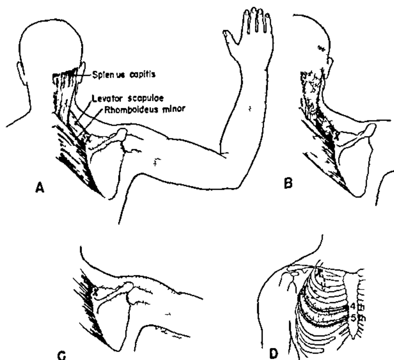


FIGURE 6 Diagramatic representation of the Scapulocostal (myofascial) syndrome (A) Shows one pattern of pain reference radiating toward the medial side of the extremity and simulating ulnar neuralgia (B) pattern of pain reference involving the posterior part of the neck in the occipital region and simulating occipital neuralgia (C) pattern of pain reference involving the shoulder girdle (D) pain reference involving the chest When chest pain is on the left side it may be mistaken for cardiac pain (After Michele)

number of other chest muscles, particularly the pectoralis, the serratus anterior, and the sternalis, may develop trigger areas which produce chest and arm pain that may be misinterpreted by the patient and physician to be of cardiac origin (Fig 7) In such cases there is no electrocardiographic or other evidence of organic heart disease On the other hand, trigger areas may develop in chest muscles as a result of cardiac ischemia Myo

our clinic (30) and also patterns noted by Travell and her associates (13, 78, 90) and by Sola and his co-workers (91)

Figure 5 depicts the muscles of the shoulder girdle most frequently affected with these disorders The *scapulocostal syndrome* deserves special mention be cause it is found in one third of the middle aged individuals presenting shoulder complaints, both sexes being equally affected (92) Postural changes, pro ducing round shoulders and drooping of the shoulder girdle, are important underlying etiological factors, but the condition is usually precipitated by fatigue and excessive use of, or injury to, the shoulder com plex At first there is a deep-seated pain in the shoulder, but later the pain may become more severe and spread to one or more of the following regions (1) up the neck to the occiput and the side of the head (2) down the back of the arm and often to the forearm, wrist, and hand, (3) around the chest, particularly along the course of the 4th and 5th inter costal nerves, and (4) a combination of these, as depicted in figure 6 Muscle spasm and limitation of motion are usually present The most significant diag nostic finding is a definite trigger point beneath the upper medial angle of the scapula in conjunction with the posterior chest wall When the pain involves only the left side of the chest, it simulates angina pectoris I have seen a number of patients who had been treated for myocardial infarction and who actually had myo fascial pain syndrome, which responded dramatically to local block therapy

A few words concerning simulation of cardiac disease by a myofascial syndrome which develops after acute trauma or, more frequently, chronic strain A

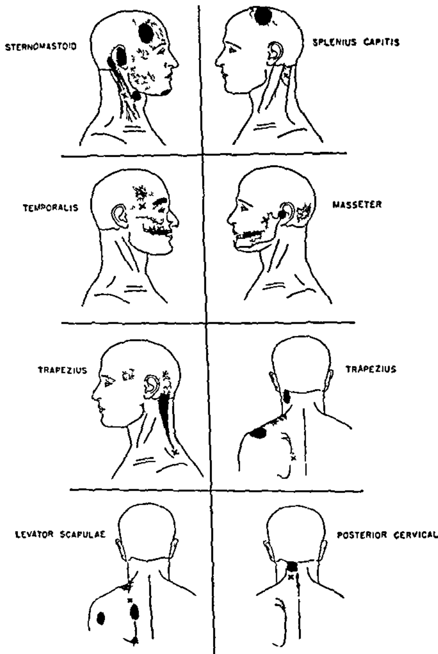


FIGURE 8 Reference pattern of myofascial pain syndromes of the head and neck.

cardial infarction produces spasm of the chest muscles as a visceromotor reflex phenomenon in a manner similar to the reflex muscle spasm associated with acute abdominal disorders This secondary muscle spasm may give rise to trigger areas which serve as a new source of noxious impulses which, in turn, give rise to pain By injecting these trigger areas, which are usually located in myofascial tissues, or by spraying the overlying cutaneous tissue with ethyl chloride, the vicious circle is interrupted and relief of the somatic pain component of cardiac disease is effected, sometimes permanently

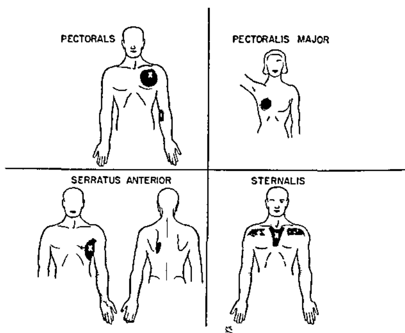


FIGURE 7 Diagram showing the most important myofascial pain syndromes of the chest Note the location of trigger areas (X) and reference of pain in 'essential' (black) and 'spill over' (stippled) zones of reference (After Travell)

thigh as well as the hip are trigger points in the tensor fasciae latae, gluteus medius, or sartorius Trigger points frequently develop after simple sprains, particularly of the ankle, and produce myofascial syndromes

Diagnosis

Diagnosis of these syndromes depends upon identification of the trigger area by noting the aggravation of pain when it is stimulated and the elimination of pain when it is injected with a local anesthetic These conditions must be differentiated from neurological, vertebral, or paravertebral lesions by thorough physical, roentgenographic, and neurological examinations The distinction is relatively simple to make, since distribution of pain of myofascial disorders does not follow distribution of nerves Moreover, there is usually no sensory deficit or reflex change with myofascial pain syndromes On the other hand, movement of the part markedly aggravates the pain of myofascial syndromes

Treatment

The treatment of myofascial pain syndromes with trigger mechanism revolves around interruptions of the pain cycle by local block of the trigger area This may be accomplished by infiltration with a local anesthetic or other material or by spraying the overlying skin with ethyl chloride The most dramatic results are obtained when the pain syndrome is due to sudden trauma, without previous history of muscular pain or stiffness In such cases spontaneous referred pain disappears very soon after the block is executed, and mechanical stimulation no longer induces reference of pain The accompanying referred tenderness, muscular spasm, limited motion, and vasomotor and sudo

Trigger points found in muscles of the suboccipital region and face are common causes of pain in the upper posterior portion of the neck, the back of the head, and the face (Fig 8)

Unilateral low-back pain in young adults is commonly found to be secondary to activation of trigger areas located at the insertion of the quadratus lumborum muscle to the transverse process of the upper three lumbar vertebrae and the 12th rib (Fig 9) The pain may be localized to the back but is frequently radiated to the lower abdominal wall and anterior thigh Other common causes of pain in the anterolateral

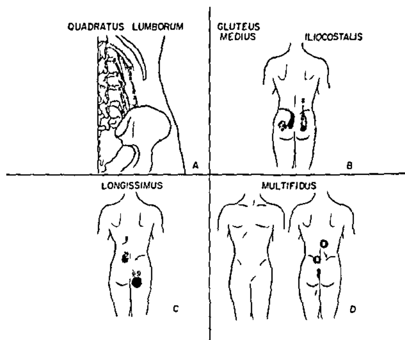


FIGURE 9 Patterns of various myofascial pain syndromes of the low back Note the location of trigger areas (X) on the insertions and the lateral edge of the quadratus lumborum (After Sola) (B C and D after Travell Courtesy *Postgraduate Medicine*)

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motor disturbances likewise disappear The explanation for such prolonged effects is discussed in p 11 If, after the block is dissipated, the pain returns, its area of distribution is smaller and its intensity less

Treatment must be directed primarily toward the trigger area and not to the zone of reference It is also important to remember that more than one trigger area may be present Therefore, for optimal results it is necessary to examine all the muscles where trigger areas producing the pain pattern could possibly be located in order that all these abnormal foci of pain can be blocked

To locate the trigger point the suspected area is palpated carefully with a finger, or the end of a fountain pen, or with the Medco-Sonlator The search should be systematic, so that every square centimeter of the surface overlying the sensitive zone or the site from which the pain arises is examined The patient is instructed to signal the operator when the point of

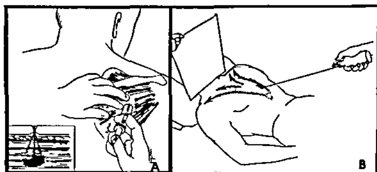


FIGURE 10 (A) Technic of injecting trigger area located in the infraspinatous muscle Insert illustrates trigger area and method of approaching it with needle in order to inject local anesthetic solution saline solution hydrocortisone or other substance (B) technic of spraying ethyl chloride for managing the sternalis syndrome Arrows indicate direction of spray (After Bonica and Travell Courtesy *J A M A*)

exquisite tenderness has been touched, this touching aggravates the pain syndrome, including the pain at the zone of reference Once the suspected spot has been found and marked with a skin pencil, the palpation is varied, and the patient is required to identify the particular spot repeatedly The trigger point or points are marked with a skin pencil, the skin is washed, and then alcohol or other antiseptic solution is applied

The injection is accomplished with a 25 gauge 5 cm needle, as depicted in figure 10A Usually 10 to 15 ml of 0 5% procaine, 0 1% tetracaine, or equi active concentrations of other drugs suffice Although good results have been reported with injections of saline solution and dry needling, experience prompts me to emphasize the superiority of local anesthetics, which are not only more effective, but diminish the discomfort associated with the injection If properly used, the incidence of toxic reactions with these drugs is negligible, since the amount is relatively small Occasionally I inject 25 mg of hydrocortisone after the infiltration with the local anesthetic

If the point of the needle is near to or actually in the trigger area, the injection causes exaggeration of the local and referred pain and tenderness This is presumptive evidence that the injection has been properly executed Confirmation is obtained if the block effects relief of pain and muscle spasm, as it does dramatically in some cases If no relief is obtained, it is most likely that the trigger point was not injected, indicating another trial A fan like approach is made by inserting the needle at different angles until the most sensitive region is contacted It is essential to obliterate the trigger areas completely by repeated in

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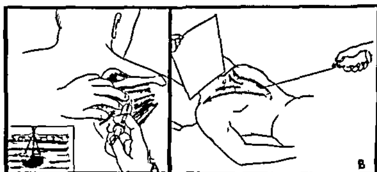


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applied at an angle with the skin, as illustrated in figure 10B* The stream is passed over the region of the trigger area and moved slowly in one direction, rather than to and fro The direction is determined by the pain reference pattern of the specific trigger areas being sprayed, the sweep should be started at the trigger area and made to travel toward the reference zone The spraying should be done with even sweeping motions, as in painting a wall It is repeated, a few seconds on and a few seconds off, until the entire reference zone has been sprayed Occasionally only one or two sprayings are sufficient, though in the majority of cases fifteen to twenty are necessary to produce the desired effects If aching develops, the interval between sweeps should be lengthened

Adjuncts to Local Block — For optimal results, it is necessary to use other therapeutic measures in addition to local block If autonomic dysfunctions are prominent, a sympathetic block is done in addition to the infiltration or spray Immediately after these procedures I frequently send the patient to the physical therapy department for heat and deep friction massage Passive and active motion of the part is an essental adjunct to treatment The patient is impressed as to the importance of his active participation in the treatment, and he is encouraged to undertake the forms of exercise he formerly enjoyed On the other hand, it is essential that the involved muscles should not be activated too rapidly or moved to a painful degree,

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*Since ethyl chloride is an inflammable and explosive general anesthetic agent certain precautions must be taken during spraying Because the vapor is heavier than air the patient should be so positioned that the vapors gravitate away from his face The room should have adequate ventilation to disperse the vapors and sources of fires and explosions such as cigarettes open flame or electric motors should be absolutely avoided

filtration, since incomplete blocking is not only partially ineffective, but is followed by increased pain after disappearance of the effects of the block

The relief of pain, tenderness, muscle spasm, and other effects persists for several hours and sometimes for days, weeks, months, or even permanently However, in many instances symptoms recur after the period of relief, frequently to an exaggerated degree The patient should be informed that such a reaction should not be considered unfavorable If the area is injected again the reaction will be much less and the secondary periods of relief will be longer and more encouraging In acute cases one treatment is sometimes sufficient, whereas in chronic cases a series of treatments is usually necessary Injections are repeated every second, third, or fourth day, depending on the severity and acuteness of the condition Further injections are indicated if the patient obtained relief or if there is change in the character of the pain

Technic of Ethyl Chloride Spray — The technic of ethyl chloride spray is so simple that some clinicians (93) employ it as the first procedure in treating myofascial pain syndromes The benefits to be derived from this form of treatment can usually be estimated at once, if the effects are encouraging, the procedure is repeated at intervals, as indicated, and cure may be obtained with this method alone If the results are not striking, the infiltration technic is used

As with the infiltration method, it is essential to locate the trigger area and to employ a proper technic The patient is made comfortable and the part to be sprayed is well supported, so that the involved muscles are relaxed The bottle of ethyl chloride is held twelve to eighteen inches away from the patient and the spray

tire muscle is infiltrated with dilute aqueous solutions of Pontocaine or Nupercaine or other long lasting agents The action of local anesthetic in these cases is to break up the vicious cycle of muscle spasm pain-muscle spasm by blocking the afferent impulses involved in pain, and by relaxing the muscle Although the use of oil solution has been favorably reported and advocated for this purpose, inherent in it are certain complications and it should be avoided

Inflammation of tendons and their investing sheaths is a common cause of discomfort, particularly in the region of the shoulder, elbow, wrist, knee, and ankle The etiology of tenosynovitis is simple or repeated trauma, and not infrequently it follows excessive use of the tendon Occasionally acute or chronic infection may produce inflammation of tendons Bicipital and peroneal tenosynovitis deserve special mention because they frequently produce serious disabilities of the upper and lower extremities Treatment consists of immediate relief of pain and preservation of motion by physical therapy The acute pain is best relieved by analgesic blocking, either by local block alone or combined with sympathetic block In some instances systemic use of steroid therapy is a valuable adjunct Occasionally in localized tendinitis and tenosynovitis, infiltration of hydrocortone into the painful inflamed area is the most effective treatment Physical therapy in the form of heat, massage, and exercise are important adjuncts

The same comments apply to the management of muscle contusions and strains which usually follow direct injury or violent contraction of the muscle In some cases the pain associated with these muscular conditions is so severe as to completely disable the patient In such instances, infiltration of the entire muscle with

especially in the early phases of treatment, since severe pain itself is deleterious in that it reflexly builds up more spasm

Definitive treatment is directed toward eliminating the predisposing and precipitating factors to prevent recurrences Psychotherapy is of importance because of the dominant etiological role played by emotional tension in some of these syndromes Since chronic trauma, secondary to poor posture, is also an important factor in the causation of the trigger areas, a program of exercise to strengthen the involved muscles should be instituted

Other Myofascial Painful Disorders

Other myofascial painful disorders which may be effectively treated with local infiltration, ethyl chloride spray, block of the segmental nerves, and various other forms of analgesic block therapy include severe muscle spasms secondary to direct injury, or as a reflex manifestation of neurologic, somatic, visceral, or psychosomatic disorders If the muscle spasm is due to a local condition, infiltration of the spastic muscle produces complete relief of the spasm and consequent relief of discomfort If the muscle spasm is a reflex manifestation, it will be necessary to direct attention and treatment to the etiologic factors and eliminate them if possible If this is not feasible, infiltration of the muscle may first be tried, but frequently one must resort to block of the nerves supplying the entire muscle In any event, analgesic blocking is without doubt the most effective and simplest way to relieve the pain and muscle spasm Of course, if trigger areas are found, injection of these is indicated, but if none is discovered, and the tenderness is generalized, the en

ing joints and periarticular structures, especially when these disorders are accompanied by severe arthralgia (joint pain), pain in an area of reference, muscle spasm, tenderness, swelling and diminution of function Analgesic block is particularly indicated when the symptomatology is severe and threatens the mobility and function of the joint Of course, the basic principles set forth in Chapter IV must be strictly adhered to in order to avoid the misuse of this method of treatment, since in many patients with arthritis and periarthritic conditions other forms of management are more effective

Joint Sprains

Simple joint sprains may be effectively treated with infiltration or with ethyl chloride spray of the most sensitive areas followed by a pressure dressing with elastoplast and by active motion Immediate resumption of active motion, made possible by the complete pain relief, enhances circulation of the part, reduction of the edema, drainage of the hematoma and consequently more rapid healing For optimal results it is necessary to spray all the painful regions so that the patient is able to resume normal activity without discomfort This method may not be used for fractures and structural instability due to severe ligamentous tears, which contraindicate the use of active motion

Following anesthetization of mild sprains, mobilization is immediate and is carried out as long as possible The procedure is repeated as frequently as necessary until the pain and edema subside This method is particularly effective in treating simple sprain of the ankle, wrist and lumbosacral joints The use of hydro-

dilute solution of local anesthetic, either alone or combined with sympathetic block, rest, and subsequently physical therapy are most effective in providing relief.

Infiltration of local anesthetic drugs into the skin, subcutaneous tissues, muscles, and other superficial somatic structures may be effective in relieving the cutaneous pain, hyperalgesia, and other referred phenomena secondary to visceral disease or deep somatic disorders. The effectiveness of local infiltration in relieving the pain in the chest consequent to cardiac disease has already been mentioned. A number of clinicians have reported relief of severe pain due to renal colic, gall bladder colic, carcinoma of the stomach, and many other visceral conditions by infiltrating the area of pain reference with local anesthetic drug. For such purposes, it is necessary to employ dilute solutions of local anesthetic agents and to inject them into the entire area of reference.

An explanation of this phenomenon has been a matter of controversy for some three decades and is beyond the scope of this book. A detailed discussion can be found elsewhere (48). It should be emphasized that the method is not effective in all instances and that the result depends upon the mechanism of the referred pain and hyperalgesia. For this reason it may be used as a diagnostic procedure to help the physician determine the mechanism producing the referred phenomena.

Pain Due To Disorders of Joints and Periarticular Structures

Local block therapy may be employed to good advantage in the management of many disorders involv-

Bursitis and Tendinitis

Infiltration of local anesthetic drug is the best method of providing immediate relief from pain, tenderness, and muscle spasm of acute bursitis This should be followed by infiltration of 10 to 25 mgm hydrocortisone which apparently causes the inflammatory reaction to subside and thus markedly decreases the duration of disability In order to obtain optimal results, it is necessary to infiltrate all the points of maximum tenderness

In patients with very severe pain and reflex sympathetic disturbances, it may be advisable to complement the local infiltration with sympathetic block of the region In rare cases it may be also necessary to completely anesthetize the region with somatic nerve block If an infectious process is present, antibiotics and/or chemotherapy should be employed

Although analgesic block is best known for the treatment of subacromial (subdeltoid) bursitis, it is also effective in the management of subscapular, olecranal, prepatellar, retrocalcanear (Achilles), subtrochanteric, iliopectineal, ischial, infrapatellar, and first metatarsal bursitis Since the advent of the steroids, the necessity for irrigation of the bursa, x-ray therapy, surgical evacuation and other more radical procedures has been markedly decreased However, they still are necessary in a few patients and should be considered whenever conservative management is ineffective in producing relief If the effusion is pronounced, frequent aspiration of the bursa is indicated

In chronic bursitis, local and other block therapy are less useful because most patients have only mild pain which may be controlled with non narcotic analgesics Physical therapy and active motion are the

cortone and other steroids in treating simple sprains may be indicated

Local block therapy is also effective in the management of patients suffering from after effects of sprain, namely pain and muscle atrophy, and those experiencing "operation sprains" characterized by pain, tenderness, and some interference of function following surgical operation on joints In many of these post traumatic or postsurgical dysfunctions there is found a trigger area which is apparently acting as a source of chronic irritation that initiates and maintains a vicious circle Infiltration in the site of irritation and/or sympathetic block is very effective in ameliorating the symptoms and shortening the patient's disability, as discussed on page 163

It should be noted that sprain of a joint, such as the finger, wrist, elbow, or knee, is occasionally followed by hemarthrosis with consequent very painful distension or stiffness In such cases the pain is greatly eased by aspiration of the hematoma followed by compression bandage

Local infiltration may also be employed as a diagnostic test in differentiating simple joint sprains from severe, partial or complete rupture of the ligaments with or without fractures Ineffectiveness of the infiltration in relieving pain and structural instability of the joint following the block strongly suggests a serious tear which contraindicates active motion and weightbearing In such instances local block therapy may be employed to relieve unusually severe pain symptomatically although most patients can be managed with pressure dressing, elevation of the foot, and ice bags

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most important forms of treatment and block therapy is reserved only for those patients who experience severe pain during physical therapy and active motion of the joint

Since inflammation of the bursa is frequently accompanied by adjacent tendinitis, it is important to infiltrate the affected tendons in order to provide optimal results This is particularly true of the supraspinatus and bicipital tendons and the other tendons which form the rotator cuff

Periarthritis

Infiltration of local anesthetic drugs and/or steroids, either alone or in combination with sympathetic blocks, is frequently effective in relieving pain and in improving the function of the joint involved in periarthritis This is a collective term for a number of different lesions of the joint, the only common feature being pain and limitation of motion The condition, which has also been called "adhesive bursitis," "adhesive capsulitis periarticular adhesions," and "painful stiff joints" frequently accompanies arthritis and also occurs with involvement of the synovia or joint capsule as a consequence of tendinitis, bursitis, fibrositis, and other myofascial disorders about the joint Obviously then, the management of the condition entails treatment of the underlying etiologic factors In the acute or subacute cases there is frequently one or more trigger areas which should be infiltrated with a local anesthetic as previously discussed

Scapulohumeral periarthritis is perhaps the most common form of this condition, probably because the shoulder is more vulnerable to musculoskeletal disorders than almost any other joint in the body Active

treatment consists of relief of pain, improvement of function of the joint, and psychologic support Although pain may be controlled with acetylsalicylic acid, either alone or combined with codeine, in many instances it is necessary to infiltrate the area with local anesthetic drugs and to complement these with cervicothoracic sympathetic block (page 163) In addition to controlling severe, spontaneous pain, block therapy is useful in permitting active motion and physical therapy, two of the most essential components of treatment It should be strongly emphasized that neither block nor any other treatment will be effective unless they are followed by active exercise Patients with chronic periarthritis, who do not respond to such conservative management, may require orthopedic intervention

Acute Arthritis and Arthralgia

Local block therapy is of little definitive therapeutic value in the management of acute infectious arthritis Infiltration may be used to advantage to provide anesthesia for aspiration of the joint which is usually necessary Some clinicians also use intraarticular injection of dilute solutions of local anesthetics, such as 0 1% Pontocaine, to provide relief following aspiration The specific form of treatment, of course, is the systematic administration and intraarticular injection of penicillin and other antibiotics

Hemarthrosis consequent to injury, surgery, or disease may cause marked distention with severe pain and stiffness which may be greatly eased by aspiration of the hematoma and subsequently by compression bandage In such instances infiltration of local anesthetic into the periarticular tissues and into the joint

is of value in providing relief during and following the procedure

Chronic Arthritis — Local block therapy is of limited value in some patients with chronic arthritis accompanied by systemic and local symptoms and signs which are dominated by intractable pain This pain enhances the tendency toward chronicity by setting up a vicious cycle of pain muscle spasm vasomotor disturbances postural defect disability-deformity-and more pain Infiltration of very painful periarticular structures and of reflexly spastic muscles together with intra articular injection of local anesthetic and steroid *compounds is frequently effective in producing much* needed relief for hours, days, and even weeks

Periarticular and intra articular injections are especially useful in managing persistent, severe pain due to degenerative arthritis of the major joints, such as the hip, knee, shoulder, and elbow It is less useful in managing arthritis of the spine, probably because it is more difficult to accurately inject the various and complex joints present in this region For reasons not entirely clear, periarticular and intra articular injections are more effective and produce longer lasting relief in patients with osteoarthritis than in patients with rheumatoid arthritis, although even these latter will benefit from this method

The technic usually employed is to infiltrate the periarticular tissues with 10 to 15 ml of a dilute solution of a long-lasting local anesthetic, such as 0 1% Pontocaine and then to inject 5 to 10 ml of this same solution into the joint as depicted in Figure 11 This is followed by intra articular injection of hydrocortisone or other steroid compounds usually in doses of 12 1/2 to 50 mgm , depending on the size of the joint With

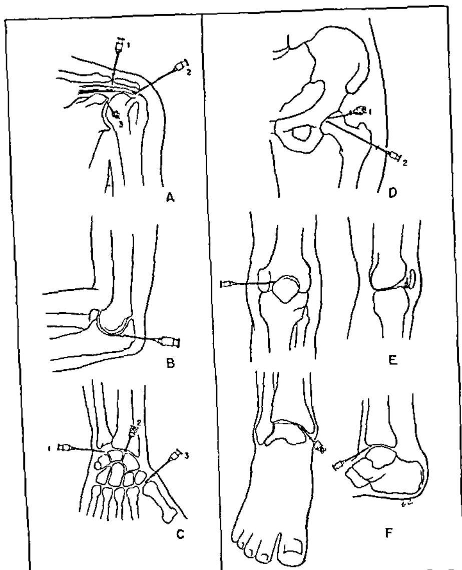


FIGURE 11 Various *technics of intra articular injection* (A) technic of injecting parts of the shoulder (1) the acromio clavicular joint (2) the supraspinatus tendon for treatment of bursitis and (3) the scapulo-humeral joint (B) Technic of injecting the elbow joint (C) Technic for intra articular in jection of the wrist by (1) ulnar approach (2) dorsal ap proach and (3) for injection in to the carpometacarpal joint of the thumb (D) Injection of the left hip by the anterior (1)

(Continued on next page)

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involvement with rheumatoid arthritis, (3) severe joint destruction or incorrected static deformity, (4) arthritis in spinal joints, (5) arthritis in other than true diarthrodial (synovial) joints, and (6) traumatic arthritis from fractures into the joint

Other Arthralgic Conditions — Generalized arthralgia due to allergic disorder has been successfully treated with intravenous administration of local anesthetic such as procaine or Pontocaine This condition is perhaps one of the few clinical disorders which indicate the use of this method Arthritis of the temporomandibular joint occasionally produces pain severe enough to require injection Painful cracking joint, which is sometimes due to recurring subluxation or tear of the intra articular meniscus of the temporomandibular joint, is relieved temporarily by injecting 1 or 2 cc of local anesthetic solution, followed by 10 to 15 mgm of hydrocortisone It is hardly necessary to add that underlying dental pathology such as malocclusion has to be corrected in order to provide permanent relief

Local block therapy is a valuable adjunct to the management of the facet syndrome in the neck and thoracic regions This condition, which is probably responsible for the familiar crick in the neck or sudden pain in the posterior chest consequent to sudden twist or jerk or injury is frequently accompanied by disabling pain In addition to infiltration of the affected joint, application of local heat and manipulation are necessary to provide relief of pain The same comments apply to the management of rib facet syndrome and mild subluxation of the facets of the lumbar vertebra

Local block therapy is also of diagnostic value in

this method the patient experiences immediate relief of pain due to the analgesic effect of the local anesthetic Subsequently he experiences partial or complete relief, probably as a result of the breaking up of the vicious circle by the local anesthetic and also, and perhaps more important, by the local effect of the steroid compound In some patients these procedures are complemented with regional sympathetic block, with systemic administration of phenylbutazone (Butazolidine), with non narcotic analgesics, and with physical therapy

It should be stressed that this should be considered a palliative and temporary form of treatment which, while it has certain specific indications, also has limitations and certain inherent complications Intra articular steroids should be used only (1) when one or only a few peripheral joints are inflamed and specific infection has been excluded as a cause, (2) in rheumatoid arthritis as an adjunct to gold therapy, (3) when systemic gold, cortisone, or ACTH therapy is contraindicated, (4) as an adjunct to systemic cortisone or ACTH therapy for control of resistant joints, (5) to assist in rehabilitation and prevention of joint deformity, and (6) as an adjunct to orthopedic procedures It is contraindicated in the presence of (1) infection in or near the joint, (2) multiplicity of joint

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and lateral (2) approaches Note that in the lateral approach the needle follows the bone to the hip joint By being inserted just anterior to the greater trochanter in a sagittal direction and pointed toward the middle of Poupart s ligament the needle point slides anterior to the periosteum and enters the joint space anteriorly near the upper reflection of the synovial sac (E) Anterior and lateral views of the technic of injecting the knee joint (F) Anterior and lateral views depicting the technic of injecting the ankle joint

pathetic disturbances which sometimes occur in such conditions (page 163)

Periostitis and epicondylitis have also been successfully treated by infiltration of local anesthetic agents and steroids Again it should be emphasized that this method of management should be employed as an adjunct to standard orthopedic and physical therapeutic measures

Trauma to the chest is sometimes followed by dislocation at the costochondral junction which produces a continuous dull, aching, burning, and often disabling pain, tenderness localized to the area of the costal margin, and occasionally referred pain in the back Local infiltration may be employed to produce anesthesia for the reduction and also to provide relief from the discomfort which usually follows such a maneuver The injection may be repeated daily until the severity of the pain is such that it can be managed with non narcotic analgesics

Traumatic separation of the costal cartilages occasionally follows injury to the lower rib cage, which is structurally the weakest point in the chest The loosened end of the cartilage slips anteriorly or posteriorly and often traumatizes the perichondrium of the rib above as well as the intercostal nerve, to produce pain of varying severity The pain is aggravated by hyperextension and by the raising of the arms and is relieved by flexion of the trunk Treatment consists of repeated injections with 0 1% Pontocaine or Nupercaine which often produces complete relief for periods of 6 to 10 hours If this method is not effective in producing prolonged relief, surgical excision of the terminal portion of the cartilage may produce a cure

Local block therapy has been employed effectively

differentiating pain due to osteoarthritis of the knee, for example, from that resulting from a tear of the internal meniscus, as the block relieves the former, but not the latter condition

Periarticular and intraarticular injection of local anesthetic drugs may be indicated in patients with severe pain which accompanies posttraumatic arthritis, both in the acute and chronic stages

Pain Due To Disorders of Bones and Cartilages

Local block therapy may be employed in the management of severe pain due to disorders of bones and cartilages It is effective in simple fractures such as chip fractures of the epicondyles of the humerus, fractures of the spinous and transverse processes of the vertebrae, undisplaced fractures of the clavicle, head of the radius, olecranon of the ulna, metacarpals and metatarsals, and any other fractures in which there is no necessity for reduction This form of therapy, however, should be reserved only for those patients who experience severe pain and perhaps associated muscle spasm, vasospasm, edema and other reflex disturbances

Infiltration of local anesthetics into the fracture site has, of course, been used for many years as an anesthetic procedure and may also be employed in permitting a patient with fractures of the long bones to have a painless journey from his room to the x ray department

In managing dislocations, local block therapy may prove valuable not only in producing anesthesia for the reduction, but also in affording relief of pain following the manipulation, and in preventing reflex sym-

scar with dilute solutions of local anesthetic drugs Occasionally it will be necessary to combine local infiltration with somatic nerve block, and/or sympathetic block if there are signs of serious reflex sympathetic disturbances These procedures are done every three to seven days until relief persists If block therapy produces only temporary relief or if there is no substantial diminution of the signs and symptoms after six to eight blocks, surgical excision of the scar should be considered

Painful Cutaneous and Subcutaneous Neuromata

Very small cutaneous and subcutaneous neuromata not associated with scar or trauma occasionally occur and sometimes produce severe pain Morton's metatarsalgia is a good example The paroxysmal pain and focal tenderness may be dramatically relieved with local infiltration of the neuroma Of course, the cause should be eliminated, and in some instances it is necessary to excise the neuroma

Painful neurofibroma may involve a small subcutaneous nerve and produce episodes of sharp, lancinating pain, which may last from a few minutes to an hour Repeated infiltration may be tried as a definitive measure and if this fails, the condition is excised

Glomangioma or glomus tumor is an extremely painful condition which usually occurs in subcutaneous or ungual regions Local infiltration provides temporary relief and is used as a diagnostic procedure Surgical excision is necessary for cure

Lipomata

Local block therapy is the best conservative method of managing patients with moderate to severe low

in controlling severe pain which sometimes accompanies Tietze's syndrome, a condition characterized by a non specific, benign, self-limiting, non suppurative, and painful swelling of the costal cartilages, most often the second, which sometimes accompanies respiratory infection The pain has a sudden onset and the swelling may progress to an irregular mass that obliterates the adjacent intercostal spaces Pain persists for a few days to a few weeks, while the swelling may continue for months In addition to blocks, treatment consists of bed rest and management of the infection

Pain Due To Cutaneous Disorders

It is well known that cutaneous scars, regardless of etiology — be they posttraumatic, postoperative, or those due to burns — are occasionally accompanied by pain and reflex disturbances which may appear long after the healing of the wound is complete Although this symptomatology due to scars may occur anywhere in the body, it is most frequently seen in the extremities and in the chest following thoracotomies

Post-laminectomy scars, especially in the lumbosacral region, are a not infrequent cause of low back disability and may indicate local infiltration therapy The scars occasionally contain tender or trigger areas which produce local pain as well as referred pain to the lower portion of the back and lower extremity, and even reflex vascular disturbances The same comments apply to the continuous, disabling pain occasionally seen in or near the iliac crest at the donor site of bone grafts

The entire symptomatology of painful and non painful cutaneous cicatrices can often be made to disappear permanently with repeated infiltration of the

generalized pruritis due to delayed serum sickness, penicillin reactions, contact dermatitis, neurodermatitis, and other cutaneous disorders

Mucous membranes of the mouth, nose, throat, and bladder are sites of disorders which sometimes produce severe pain that cannot be managed adequately with the usual systemic analgesics In such instances repeated topical application of local anesthetic will provide much needed relief

back pain due to subcutaneous lipomata These are painful, tender nodules found in the episacral, sacro iliac, and lumbar regions, and consist of small fat masses which have herniated through the lumbosacral fascia Pressure of the nodule or muscular activity may cause a bout of severe low back pain and muscle spasm Formerly these were excised, but now they are being satisfactorily managed with repeated injection of local anesthetic drugs, which usually provide dra matic relief of pain Although for some reason this condition is found predominantly in the low back region, it may develop in any other region of the body

Other Cutaneous Lesions

Abrasions, burns, and necrosis of skin and mucous membranes may be causes of severe pain which may indicate some form of local block therapy, in addition to the usual standard surgical management Topical application of dilute solutions of local anesthetics sprayed or incorporated in a paste or other preparation which may be applied locally is very effective in relieving the discomfort Care to avoid toxic reaction from overdosage should be exercised by employing dilute solutions of the drugs It should be appreciated that following application of local anesthetic drugs to abraised or burned skin or mucous membranes the absorption is almost as rapid as following intravenous infusion Therefore extreme care should be exercised not to exceed the total dosage suggested in Table III (Page 81) If these conditions are extensive, it may be advisable to employ intravenous administration of local anesthetics such as procaine or ponto caine This latter method is particularly useful in controlling the discomfort of extensive burns and

with these one can block specific sympathetic pathways Obviously the same holds true where alcohol is

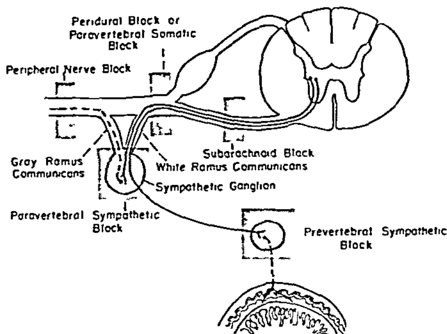


FIGURE 12 The course of preganglionic and postganglionic sympathetic fibers and the technics that may be used to interrupt them.

used for therapeutic blocks since the volume must be limited to 2 to 3 ml of solution On the other hand, if large volumes of local anesthetic can be used for treatment, it is not necessary to block all the ganglia separately because the peripheral sympathetic pathways are so arranged anatomically that they can be interrupted at certain critical regions

Recent studies with contrast media have demonstrated the facility of blocking the entire peripheral sympathetic outflow by placing a needle in each of three of these critical sites, as depicted in Figure 13, 10 ml of the solution injected into the proper fascial

Chapter IX

BLOCKS OF SYMPATHETIC AND OTHER AUTONOMIC NERVES

IN RECENT YEARS the functional relationship between the autonomic nervous system and many disease syndromes has been clearly established. Moreover, a vast amount of experimental and clinical evidence has been accumulated which indicates that interruption of certain portions of the autonomic nervous system has beneficial effects in a great many of these disorders. Of the methods which have been devised to achieve this interruption, chemical block of the involved sympathetic pathways by injection of a local anesthetic or neurolytic agent is one of the most effective and clinically practical.

It is well known that clinical interruption of peripheral sympathetic pathways may be achieved in the (1) subarachnoid space, (2) peridural space, (3) paravertebral and prevertebral regions, and (4) peripheral nerves. Since subarachnoid, extradural, and peripheral nerve blocks will be discussed in subsequent chapters, the present discussion is limited to comments concerning paravertebral and prevertebral sympathetic blocks. For diagnostic and prognostic blocks, segmental paravertebral injections are preferable because

plane in the proximity of the stellate ganglion spreads to involve the sympathetic chain from the middle cervical to the 4th or 5th thoracic ganglion, so that all the sympathetic fibers to the head and neck, upper extremity and chest are interrupted, the same amount of solution injected near the celiac plexus spreads sufficiently to interrupt all the sympathetic fibers to the abdomen, an injection through a needle with its tip at the anterolateral surface of the 2nd lumbar vertebra interrupts all sympathetic fibers to the lower extremities and pelvis Apparently these sympathetic nerve structures are contained within fascial places which may be considered as relatively closed spaces or even "pouches" which facilitate the spread of the local anesthetic solution in directions that will cause it to produce such an extensive sympathetic block

DISORDERS OF THE EXTREMITIES

Causalgia and Other Reflex Sympathetic Dystrophies

One of the most frequent and most productive uses of sympathetic nerve blocks is in the management of reflex sympathetic dystrophy This is an all-inclusive term which has been recently applied to a great variety of seemingly unrelated disorders previously described under such terms as major causalgia, posttraumatic painful osteoporosis, Sudek's atrophy, posttraumatic spreading neuralgia, minor causalgia, posttraumatic

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jected in the vicinity of the cervicothoracic (stellate) ganglion celiac plexus and lumbar sympathetic ganglia. On the readers right are the names of the structures affected with each block. (After F A D Alexander)

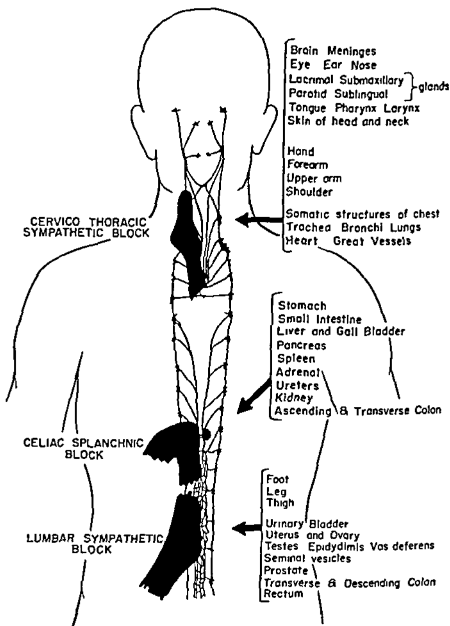


FIGURE 13 Diagram illustrating the three critical sites which may be employed to interrupt the peripheral sympathetic nervous system *On the reader s left the diagram shows the* pattern of diffusion (black) of local anesthetic solutions in

(Continued on next page)

pain syndrome, sympathalgia, shoulder-hand syndrome, chronic traumatic edema, and reflex dystrophy, among others (48) These syndromes appear to be similar in etiology, in clinical manifestation, and in response to therapy and are characterized by excessive or unduly prolonged pain, vasomotor disturbances, delayed functional recovery, and trophic changes

The signs and symptoms may be present in varying degrees or one may be so severe as almost to obscure the others The pain may be excruciating and constant, or it may be dull, aching, throbbing, and present only

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upper extremities are supplied by preganglionic fibers which have their cell bodies at levels T2 to T8 and occasionally T9 of the spinal cord These ascend the paravertebral sympathetic chain and synapse with postganglionic fibers mainly in the second thoracic and stellate ganglia The postganglionic fibers which pass directly to the subclavian artery form a plexiform network called the subclavian axillary plexuses investing and accompanying the vessels as far as the axilla The arterial tree distal to this point is supplied by sympathetic fibers conveyed peripheralward by the brachial plexus and its constituent nerves particularly the median radial and ulnar nerves It should be noted that injection of solution in the vicinity of the stellate ganglion will interrupt all of these fibers These vascular fibers are distributed to the various blood vessels at irregular intervals and have the same distribution as the nerves which convey them The lower extremity is supplied by preganglionic fibers which have their cell bodies in levels of T10 to L2 of the spinal cord and synapse in the lumbar and sacral portion of the paravertebral sympathetic chain The postganglionic fibers which pass directly to the iliac and femoral arteries extend to the proximal portion of the femoral artery The arterial tree distal to this point is supplied with fibers passing in the femoral obturator and sciatic nerves Injection of solution into the vicinity of the 2nd lumbar ganglion will likely interrupt all fibers to the lower extremity

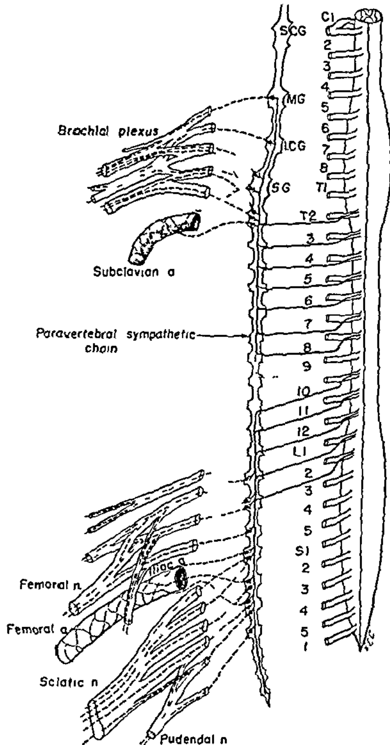


FIGURE 14 Diagram showing the course of the sympathetic pathway for the upper and lower extremities Note that the

(Continued on next page)

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upon motion An important characteristic of the pain is that it is not limited to segmental (dermatomal) or peripheral nerve distribution In most instances, the vasomotor changes are in the form of vasoconstriction, and the skin of the extremity is cold, damp, and glistens, although occasionally vasodilatation may be present and the skin will be warm, dry, and scaly Early edema is commonly present, but as the disease pursues its uninterrupted course, atrophy of the skin, subcutaneous tissue, muscle and tendon, and osteopo rosis of the bone develops Trophic changes are con stant, but are variable in degree and extent

The etiology may vary from a very trivial injury to the severance of a major nerve, as occurs in classical causalgia Apparently, the trauma or infection stim ulates and injures nerve fibers and thus produces an irritative lesion, which serves as a chronic focus that constantly bombards the spinal cord with an abnormal number of noxious impulses Instead of the usual orderly process of healing (characterized by subsidence and disappearance of pain, return of circulatory homeostasis restoration of function, and wound healing) there is the disorderly response described above This is apparently the result of dysfunction of the internuncial pool and widespread excitation which activates central stations into a frenzy of activity (19) This abnormal activity spreads and implicates anterior and lateral horn cells, resulting in sympathetic hyperactivity and consequent vasospasm, as well as skeletal mus cle spasm and abnormal increase of the other reflex mechanisms In this way, a vicious circle is set up

On the basis of etiology, onset and severity of symp tomatology, and response to therapy, these disorders may be classified into three types (24) severe (grade

I), moderate (grade II), and mild (grade III) Moreover, without proper treatment, each type may progress from the acute to the subacute and finally to the chronic stage Symptoms are most prominent in the acute stage In the subacute stage there is gradual decrease of pain, spread of edema, increased thickness of the joint, and muscular wasting Trophic changes become prominent with progression of the disease The chronic stage is characterized by marked trophic changes which eventually progress to irreversible degrees

Causalgia and Other Severe (Grade 1) Reflex Sympathetic Dystrophies

Causalgia of the major type has such clearcut and characteristic features that it deserves consideration by itself and has an exclusive claim to the name (49) Sympathetic blocks always produce relief of the excruciating burning pain and severe hyperalgesia and should be done as diagnostic and prognostic blocks The analgesic effect of sympathetic block is so constant that some authorities consider this as a cardinal diagnostic feature of causalgia (94) If sympathetic interruption is instituted promptly after the onset of the disorder and continued for several days, either by means of continuous technic or better still by injecting phenol, prolonged relief may be effected But even if such results are not obtained, prolonged sympathetic block is of value to afford the patient respite from his intense suffering and thus better prepare him physically and psychologically for the operation Unfortunately, in most patients, nothing short of surgical sympathectomy can halt this process permanently, since the

initiating factor has set up a self-perpetuating vicious cycle (24, 49, 95)

The same comments apply to severe (grade I) reflex dystrophy which is manifested by severe symptoms similar to these of causalgia without involvement of a major nerve

Moderate and Mild Reflex Sympathetic Dystrophy (Grade II and III)

These are milder forms of the disease characterized by a slower onset, and of longer duration Pain is usually dull, throbbing, aching and diffuse, aggravated by motion and relieved by mobilization and rest Vasoconstriction or vasodilatation is almost always present but is usually mild, as are the trophic changes, especially osteoporosis Voluntary restriction of motion usually results in aggravation of the trophic changes and organic changes in joints which eventually seriously limit the function of the extremity

Early institution of continuous sympathetic block which is maintained for two to three weeks is usually effective in completely relieving pain, restoring circulation to normal, permitting full motion, and in overcoming the perpetuating factor of the disease, so that trophic sequelae are minimized For optimal results, it is essential that the block be instituted early and that the sympathetic interruption be continuous and prolonged This can be effected by the so-called continuous technic, or by the injection of phenol, which produces a truly continuous interruption for several days without any of the technical difficulties usually encountered with the catheter technic

It needs to be stressed that in the chronic cases,

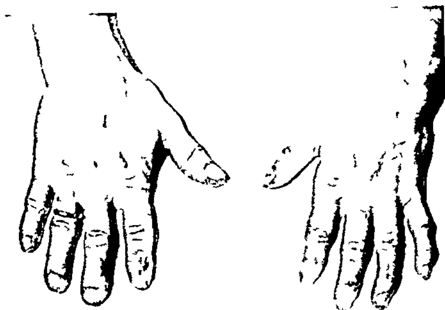


FIGURE 15 Photograph of the hands of a patient with reflex sympathetic dystrophy involving the upper left extremity Note the difference in the color and texture of the skin and the coarse hair (From Bonica *Management of Pain* Courtesy Lea & Febiger)

physical therapy, exercise, and psychotherapy are important adjuvants, without which a favorable outcome is precluded When organic changes, such as shortening of tendons, are present in the advanced cases, orthopedic care is necessary for functional recovery after sympathectomy In any case, it is important to consider and muster all possible therapeutic agents, and neglect no useful adjuvant in treatment

Pain After Amputation

Following amputation of an extremity, pain may develop in the phantom limb, or it may develop in the stump The quality of the pain which is experienced

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blocks are of therapeutic as well as diagnostic value, whereas in patients with chronic vasospastic and organic disorders this method is best used only as a diagnostic prognostic tool

Acute Peripheral Vascular Disorders

In our experience repeated or prolonged sympathetic block effected by the catheter technic have been of significant therapeutic value in patients with traumatic segmentary vasospasm, acute arterial occlusion, arterial aneurysm, acute thrombophlebitis, and circulatory insufficiency secondary to frostbite, trench foot, and immersion foot In all of these conditions the local lesion, whether it be the result of trauma, embolism, thrombosis, chemical irritation, infection, or anoxia sets up reflex spasm of the collateral vessels that aggravates the circulatory insufficiency which is now much greater than would occur were the collateral vessels not so effected Sympathetic block promptly initiated before changes which favor thrombosis occur in the endothelium of the vasospastic collateral vessels results in reestablishment of normal flow through the collaterals, and may thus prevent gangrene

When trauma necessitates *ligation of major peripheral arteries*, the best treatment, of course, is the use of vascular grafts However, concomitant sympathetic interruption may aid the circulation of the limb by *eliminating reflex spasm* and producing maximal dilatation of collateral vessels (97) Since such therapeutic effect is needed only for a matter of days or weeks, it is best to produce sympathetic interruption by phenol or by means of a continuous peridural block which may be also used for anesthesia for the operation

Sympathetic block may also be used as a diagnostic

in the phantom limb may be of two rather distinct types (1) a burning and throbbing pain, (not unlike that of reflex sympathetic dystrophy) which the patient describes as if the hand or foot were held too close to a fire, and (2) an extremely abnormal position and tension on the phantom limb which is uncomfortable The pain in the stump may also be of two types (1) a constant, diffuse, burning, throbbing pain, or (2) a paroxysm of lancinating, shooting discomfort which has a segmental or peripheral nerve distribution

In patients who complain of burning, aching, dis comfort, sympathetic blocks should be employed as diagnostic and prognostic procedures, especially if these are associated with vasomotor and trophic changes in the stump If the block affords complete relief of pain, it should be repeated on several occasions to confirm the results and also to ascertain the duration of the relief If relief is of progressively longer duration and outlasts significantly the duration of the block, injection of phenol or sympathectomy should be seriously considered In two of our patients sympathectomy and excision of neuroma have effected a cure Unfortunately, this is not the usual response, and frequently the patients require chordotomy (95) In passing, it should be mentioned that prior to this operation it is advisable to use a subarachnoid block to predict the effect of operation

Peripheral Vascular Disease

One of the most important indications for sympathetic block is the management of peripheral vascular diseases The indication of blocks depends primarily on the nature of the disease and the degree of vaso spasm In general, in patients with acute vasospasm,

of hemorrhage due to the subsequent anticoagulant therapy, as well as to produce sympathetic interruption In addition, it may be used to provide anesthesia for the operation and may be continued postoperatively to control postoperative pain and produce continuous sympathetic interruption It should be stressed that the block must be instituted before the anticoagulant therapy, otherwise there is danger of serious hemorrhage

Peripheral vascular disorders resulting from exposure to cold, such as trench foot and frostbite, are frequently characterized by initial and late vasospastic phase and intermediate hyperemic phase Prompt institution of continuous sympathetic block will likely relieve the symptoms of the first phase and may decrease the degree of tissue damage In the late phase, vasospasm and the consequent coldness, pain, paresthesia, hyperhidrosis and stiffness are chronic Therefore, although transient blocks are of diagnostic-prognostic value, the best therapeutic effects are produced by sympathectomy However, even sympathectomy will not obviate amputation in severe cases with gangrene

Acute thrombophlebitis is frequently characterized by severe pain and/or marked edema and excessive perspiration, due to abnormal reflex spasm of the arterioles and venules Prompt institution and continuation of sympathetic blocks result in prompt relief of pain and subsidence of discoloration, edema, and sudomotor changes Blocks should be initiated before anticoagulants are administered to avoid any serious hemorrhage

This brings up the question of the concomitant use of anticoagulant therapy with sympathetic block The

or therapeutic procedure in the management of occlusive arteriospasm without laceration This condition, referred to by some writers as *traumatic segmentary vasospasm*, is characterized by severe reflex spasm of an artery following acute single injuries or repeated trauma and is manifested by a cold, cyanotic, painful, and edematous extremity Although the vessels are not injured grossly, the degree of vasospasm may be so severe as to produce ischemia and consequent gangrene comparable to that produced by intraluminal obstruction or section of the vessels In such cases, sympathetic blocks may be used to determine whether the severe ischemia is the result of organic obstruction or actual division of the blood vessel, or merely due to severe spasm Continuous epidural block is especially useful in such cases because it affords relief of the severe ischemic neuralgia as well as producing prolonged sympathetic interruption which occasionally is sufficient to produce a cure

Regional sympathetic blocks may also be used as a preliminary or concomitant measure to surgical correction of an *arterial or arteriovenous aneurysm* For optimal results the interruption should be continuous, and it is best effected by chemical or surgical sympathectomy Segmental epidural block may provide anesthesia for the operation and may be employed in the postoperative period to effect relief of postoperative pain and continuous *sympathetic interruption*

The *acute occlusion of a major peripheral vessel* by embolus is best treated by embolectomy, anticoagulant therapy, and concomitant sympathetic interruption In such circumstances I prefer to institute a peridural block immediately so as to provide relief of pain during the preoperative period and to minimize the danger

of hemorrhage due to the subsequent anticoagulant therapy, as well as to produce sympathetic interruption In addition, it may be used to provide anesthesia for the operation and may be continued postoperatively to control postoperative pain and produce continuous sympathetic interruption It should be stressed that the block must be instituted before the anticoagulant therapy, otherwise there is danger of serious hemorrhage

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two aims in the therapy of vascular spasm secondary to thrombosis or embolism are to reduce the spasm itself by sympathetic block and to prevent further clotting by anticoagulant drug administration However, because of the reports of uncontrollable hemorrhage following the use of anticoagulants and sympathetic blocks concomitantly, most authorities advise against their use at the same time (85) There are some, however, who believe that if the nerve block procedure is executed with utmost skill, these two methods can be combined to the greater advantage of the patient (98) This is true if these requisites are followed and both methods are considered essential in the management of the case However, since in many instances patients who require anticoagulant therapy really do not absolutely need a sympathetic block, it is best to avoid the risk of hemorrhage and rely on anticoagulant therapy alone

Chronic Vasospastic Disease

In patients with *Raynaud's disease* and other chronic vasospastic disorders, sympathectomy is usually necessary to provide best results if sympathetic interruption is indicated because of the persistent chronic nature of the local stimulus Although prolonged improvement in some patients with these conditions has been reported following temporary sympathetic blocks, these should be considered merely as diagnostic prognostic tools As previously mentioned, these procedures are extremely valuable in ascertaining the degree of vasospasm and predicting the effects of sympathectomy In very unusual circumstances I have done a chemical sympathectomy with phenol or alcohol as a substitute for surgery with good results However, it should be

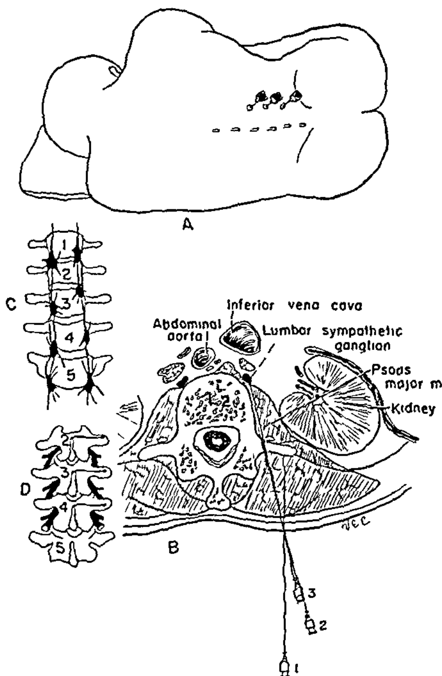


FIGURE 16 Anatomy and *technic of blocking the lumbar sympathetic ganglia* by the paravertebral approach (A) Posi

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stressed that since most of these patients are relatively young and in good physical condition, they should be afforded the benefit of the more specific procedure of surgical sympathectomy

In patients with *Raynaud's phenomenon*, it is necessary to ascertain the underlying cause and eliminate it If this is not possible, and if prognostic sympathetic blocks indicate that interruption will benefit the patient, sympathectomy should be considered Intermittent vasospasm characteristic of Raynaud's phenomenon is frequently one of the early manifestations of *scleroderma* In such cases chemical or surgical sympathectomy of the extremity is indicated Although a number of French writers (35) have reported improvement with transient blocks, the latter are of most value as prognostic procedures

Patients with *anterior poliomyelitis or other lesions of the spinal cord* occasionally manifest severe degrees of vasospasm with consequent coldness, cyanosis, and discomfort of their paralyzed extremity Some clinicians (99) have reported good results with repeated sympathetic blocks, but in most instances chemical or

tion of the patient for unilateral block Note the skin wheals are opposite the upper edge of the spinous processes of the 1st 2nd and 3rd lumbar vertebra (B) Cross section showing details of technic The ganglia are on the anterolateral surface of the vertebra anterior to the margin of the psoas major muscle and posterior to the large vessels and abdominal viscera In the diagram needle 1, depicting the first step of the procedure impinges the transverse process, needle 2 the lateral surface of the vertebra and needle 3 with its point in the proximity of the lumbar sympathetic chain (C) Anterior, and (D) posterior view of the vertebral column showing relation of sympathetic chain The lines in (D) indicate the landmarks used on the overlying skin (After Bonica *Management of Pain* Courtesy Lea & Febiger)

better still surgical sympathectomy is necessary for lasting benefit Sympathetic blocks are used to predict the effect of the operation

Acrocyanosis is a vasospastic disorder manifested by persistent coldness, intense cyanosis and frequently edema and hyperhidrosis Some patients respond to

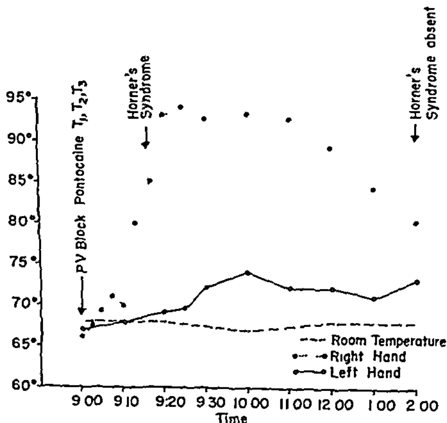


FIGURE 17 (A) Temperature curve in a patient with Raynaud s disease in response to right paravertebral sympathetic block. Note the immediate rise of the temperature and almost simultaneous development of Horner s syndrome indicating interruption of sympathetic fibers to the head

repeated sympathetic blocks, but in persistent cases sympathectomy will be necessary *Livedo reticularis* is characterized by marble like mottling of the skin, which is aggravated by exposure to cold Repeated sympathetic blocks may be tried to effect a cure If these provide temporary relief, sympathectomy should be considered

Erythromelalgia is almost the exact antithesis of Raynaud's disease and acrocyanosis It is characterized by redness and burning pain in the extremities due to abnormal vasodilatation Although the vessels are already abnormally dilated, sympathectomy has proven of great value in two of our patients Similar brilliant results have been reported by others (95) The basis for such effects is not definitely known, but is probably due to the stabilization of blood flow and the abolition of marked changes due to inhibition of vasoconstriction Or it may be due to reflexly induced vasoconstriction, or perhaps to the interruption of sympathetic vasodilatory fibers Sympathetic blocks are very useful to predict the effect of the operation

Chronic Obliterative Disease

In *thrombo-angiitis obliterans* there is a constant and occasionally marked arteriolar spasm, which constitutes the principle cause of the intermittent claudication This is particularly true in the early stages of the disease when it may be difficult to distinguish this condition from a primary vasomotor disorder Transient block of the sympathetic ganglia gives temporary release of the vasospasm and relief of pain, but is of no value as a therapeutic measure Although skin temperature, oscillometric and plethysmographic studies can be used in selecting patients for sympathectomy, it is

advisable to rely on the walking tolerance test as the best criterion to ascertain the amount of increase in peripheral blood flow Prognostic sympathetic blocks constitute a reliable test method to predict the effects of sympathectomy, and if the patient is able to walk a significantly greater distance following the block, sympathectomy is recommended Of course, in the advanced stages of the disease, when all the pulses in the main arteries, including that in the femoral artery, are lost, and ulceration, infection, and gangrene are present, sympathectomy will probably be of little definitive value, but may be combined with a bypass operation

Arteriosclerosis obliterans is best treated by surgical means Temporary sympathetic blocks are of no therapeutic benefit and of little or no value in predicting the effects of sympathectomy because in most of these patients there is no increase, but a persistence of normal vasomotor tone Apparently, the interruption of sympathetic impulses is not sufficiently long for improvement to be observed While a good response to the block indicates a good result with sympathectomy, no response does not necessarily indicate a poor result and the patient should not be rejected for operation just on the basis of a negative result with the block Chemical sympathectomy with phenol may be used as a substitute for the operation in patients who refuse operation and in those who are in extremely poor physical condition (100) However, since lumbar sympathectomy in the hands of a well trained surgeon imposes little stress on the patient, surgical denervation should be done In some patients the best results are obtained by vascular grafts In such cases concomitant surgical or chemical sympathectomy may be of value

Although results following blocks are not as good

repeated sympathetic blocks, but in persistent cases sympathectomy will be necessary. *Livedo reticularis* is characterized by marble-like mottling of the skin, which is aggravated by exposure to cold. Repeated sympathetic blocks may be tried to effect a cure. If these provide temporary relief, sympathectomy should be considered.

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Other Disorders of the Extremities

Acute Musculoskeletal Disorders

In some patients with acute bursitis, tendinitis, tenosynovitis, and other acute traumatic and infectious musculoskeletal disorders, there is a considerable degree of reflex vasospasm and hyperhidrosis, which tends to aggravate the physiopathology Sympathetic blocks, used alone or in combination with local infiltration of trigger areas or other especially tender regions, are frequently effective in ameliorating the symptomatology and shortening the disability It must be reemphasized that this method should be considered merely as an adjunct The same comments may be made in the treatment of scapulohumeral periarthritis, a chronic condition that may be beneficially affected by sympathetic blocks

In some patients with scalenus anticus syndrome stellate ganglion block enhances the beneficial effects of the infiltration of the muscle, especially if marked vasomotor disturbances are present

Chronic Musculoskeletal Disorders

Sympathetic blocks have been advocated to predict the effect of sympathectomy and/or the treatment of several other chronic musculoskeletal disorders which include retardation of growth following poliomyelitis, Charcot joint, arthritis and delayed or nonunion of fractures Some writers have suggested that in all these conditions there is an element of vasospasm or decrease in vascularity and, therefore, that prolonged sympathetic interruption is warranted In my experience, therapeutic sympathetic blocks have proven useless in these conditions Perhaps if there is evidence of

in *chronic thrombophlebitis* as in the acute phase, they are nevertheless positive, particularly regarding edema and pain. Ochsner and his associates (101) have used this method as a therapeutic measure as well as a means of ascertaining the degree of vasospasm present prior to sympathectomy. Chronic ulceration of the extremities may be a postphlebitic sequela, which indicates sympathetic blocks to determine the presence and degree of vasospasm. If vasospasm is present, prolonged sympathetic interruption with phenol or alcohol or sympathectomy should precede any operative intervention in order to increase blood flow and to facilitate healing.

Hyperhidrosis

Hyperhidrosis of nervous origin is a disorder of sudomotor function due to sympathetic hyperactivity and is most frequently limited to the hands and feet. In general, medical treatment with Banthine and other cholinergic blocking agents is not practical because of its widespread undesirable effects. In severe cases, interruption of the regional sympathetic nerves to the hand and feet is indicated. Sympathetic blocks are used to predict the effects of sympathectomy, and under unusual circumstances prolonged blocks with phenol or alcohol may be done for therapeutic purposes. However, surgical denervation is preferable because its effects are more certain and the operative risk is minimal in this group of patients, most of whom are young and otherwise in good health.

Other Disorders of the Extremities

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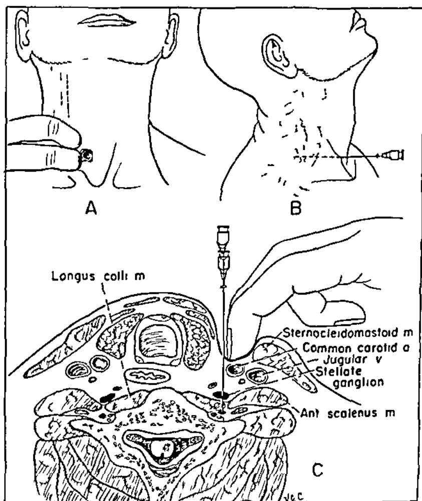


FIGURE 18 *Technic of stellate ganglion block* by the anterior (paratracheal) approach (A) Anterior view showing the maneuver of retracting the large vessels laterally and placing the needle medial to the fingers (B) Lateral view showing the needle in place with its tip on the base of the transverse process of the 7th cervical vertebra (C) Cross section depicting the technic Note the relationship of the fingers to the common carotid and jugular vein and these to the stellate ganglion After contact with the bone the needle is withdrawn about 5 mm until its point is anterior to the longus colli muscles and in the same fascial plane as the stellate ganglion Injection of

(Continued on next page)

severe sympathetic hyperactivity in the form of vasospasm, cyanosis, pain, and increased perspiration, prognostic sympathetic blocks are indicated, and, if the results warrant it, sympathectomy should be done

DISORDERS OF THE HEAD AND NECK

Many writers report brilliant success with the use of sympathetic block in the treatment of various disorders of the head and neck The French literature particularly contains many glowing reports of the efficacy of stellate ganglion block in the treatment of these conditions (34, 35, 38) Unfortunately, in our clinic, as well as in others, therapeutic blocks of the autonomic nerves of the head and neck have proven ineffective (47, 49) However, since reports appear persistently in the literature, a brief discussion of these conditions is in order

Ophthalmologic Diseases

Various ophthalmologic disorders, including obstruction of the central retinal artery due to embolism or thrombosis, acute optic neuritis, toxemic and hypertensive retinitis of pregnancy, chronic optic atrophy, retinitis pigmentosa, and glaucoma have been treated with sympathetic block on the premise that these conditions entail marked spasm of the arteries to the eye From the results obtained, I am prompted to state unequivocally that sympathetic interruption is of no

the solution in this fascial plane permits its diffusion cephalad to involve the lower portion of the cervical sympathetic chain and caudad to affect the upper portion of the upper thoracic chain Should the needle not be withdrawn and the injection made into the muscle the diffusion of drug will be limited

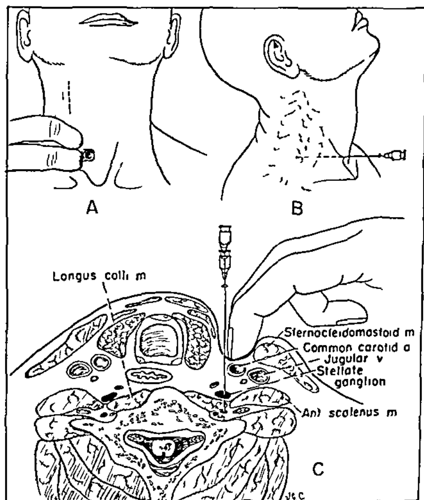


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therapeutic value in the treatment of these conditions Perhaps in patients with acute posttraumatic spasm of the central retinal artery one is justified in carrying out a block with a long lasting local anesthetic agent such as pontocaine on the chance that it will relieve the spasm

Diseases of the Nose, Throat and Ear

Dramatic results have been reported with cervicothoracic sympathetic block in the treatment of vertigo and tinnitus, deafness, atrophic rhinitis, and aphonias Since most of these conditions are due to structural changes of special organs, it is difficult to rationalize such results, and it is likely that these dramatic effects represent psychotherapeutic effects on the patient or the physician or both Nerve blocks should not be considered in the management of these conditions

Facial Disorders

During the past one half century isolated reports have appeared yearly in the literature concerning the successful treatment by sympathetic interruption of various facial conditions such as atypical facial neuralgia, so-called Sluder's neuralgia, facial palsy, and migraine Undoubtedly, some of these patients derived benefit from the non specific psychotherapeutic (placebo) effects of the block, as this type of patient would from any procedure, but unfortunately the bene fit was short lived In my opinion, sympathetic blocks are of no value, either as diagnostic or therapeutic pro-

cervicothoracic sympathetic (stellate) ganglion The diffusion extends from the level of the 6th cervical vertebra to the upper portion of the 4th thoracic vertebra (From Moore *Regional Block* Charles C Thomas Publisher)



FIGURE 19 Roentgenogram showing pattern of diffusion produced by injecting Diodrast solution into the vicinity of the

(Continued on next page.)

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Cerebrovascular Accidents

Over the usefulness of stellate ganglion block in the management of cerebrovascular accidents has been conducted one of the most intense controversies in recent years Since 1936, when Leriche and Fontaine first proposed the use of this method for the treatment of vasospasm consequent to acute cerebrovascular accidents, numerous favorable reports have appeared in the literature (102) These reports indicate that cervico thoracic sympathetic blocks accelerate and enhance the recovery of patients who have recently suffered an apopletic stroke On the other hand, several groups have reported this method to be totally ineffective in producing improvement

In our clinic this method has been used in approximately 60 patients with acute hemiplegia due to cerebral thrombosis, embolism, or vasospasm Of this group, six experienced an immediate marked improvement promptly after stellate ganglion block had been completed, while another 10 had moderate improvement within the first twenty four hours In view of the known vagaries of cerebrovascular accidents and the tendency to spontaneous recovery, these results cannot be considered as very significant However, since stellate block is a relatively simple procedure, it may be tried in these patients provided intracranial hemorrhage is first ruled out In order to afford the

patients the best chance of recovery, it is suggested that the block be carried out with phenol prior to the initiation of anticoagulant therapy Of course, the injection should be carried out on the side opposite to the hemiplegia

Some writers have also reported the usefulness of stellate ganglion block as an adjunct in the management of patients with residual effects of cerebrovascular accidents In my experience, as well as that of others, this method is of little value except as a psychotherapeutic measure Since most of these patients are usually neglected therapeutically, any procedure which makes them feel that something is being done for them will be beneficial

Stellate ganglion block has also been advocated as an adjunctive measure to be used prior to and during the ligation of large vessels to the head, and in the treatment of cerebral spasm induced by intra-arterial injection of contrast media (103) In our practice this measure has not been deemed necessary for these purposes, and, therefore, I cannot give an opinion on its value

In past years sympathectomy has been advocated for the treatment of epilepsy and spastic paralysis, but unfortunately, the results have been most disappointing (95) Sympathetic denervation of the brain has been given an adequate trial in the treatment of these conditions It has been found to give no assistance in the controlling of convulsive states and to effect no reduction in the degree of spasticity in patients with paralysis In view of these results, the use of cervicothoracic sympathetic blocks, either as a diagnostic or therapeutic measure should not be considered

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prognostic, or therapeutic measure. Its value in the differentiation of pain of cardiac origin from pain due to abdominal disorders has been mentioned. It should always be used as a test to predict the effect of sympathectomy. Leriche and his pupils have used and advocated the use of repeated cervicothoracic sympathetic blocks with procaine as a prophylactic measure to prevent future anginal attacks or to decrease their incidence. They base this practice on the assumption that the pain is due primarily to coronary vasospasm, the relief of which at frequent intervals with blocks results in improvement of the coronary circulation and correction of the myocardial imbalance. Since angina pectoris is predominantly due to sclerosis of the coro-



FIGURE 20 Roentgenograms showing position of the needle for injecting the right upper five thoracic sympathetic ganglia in a patient with angina pectoris. Note diffusion (white arrows) of 2 cc of 35% Diodrast injected through each needle (black arrows). (Bonica: *Management of Pain*. Courtesy Lea & Febiger.)

Painful Disorders of the Head and Neck

Blocks of the cervical and upper thoracic sympathetic nerves have been used in the management of various painful disorders of the face, head and neck, including occipital neuralgia and herpes zoster, but the results have been equivocal and do not warrant recommendation of this method In patients with cancer pain that has a burning component it may be advisable to complement cranial nerve block with block of the cervical sympathetic nerves

Parasympathetic Disorders of the Head and Neck

Nerve blocks may be used to great advantage in the management of various unusual conditions which involve parasympathetic pathways of the head and neck These conditions include the carotid sinus syndrome, the Marcus Gunn phenomenon, the Heidenhain phenomenon, the Vulpian phenomenon, the auriculotemporal syndrome, gustatory sweating, and the phenomenon of crocodile tears, all of which are discussed in Chapter XIII

DISEASES OF THE CHEST

Pain of Cardiac and Aortic Origin

Angina Pectoris

Angina pectoris constitutes one of the most important indications for sympathetic nerve block By a block of the upper four or five thoracic sympathetic ganglia, all of the sympathetic nerves, as well as all of the pain fibers to the heart and great vessels, are interrupted This procedure may be used as a diagnostic,

prognostic, or therapeutic measure Its value in the differentiation of pain of cardiac origin from pain due to abdominal disorders has been mentioned It should always be used as a test to predict the effect of sympathectomy Leriche and his pupils have used and advocated the use of repeated cervicothoracic sympathetic blocks with procaine as a prophylactic measure to prevent future anginal attacks or to decrease their incidence They base this practice on the assumption that the pain is due primarily to coronary vasospasm, the relief of which at frequent intervals with blocks results in improvement of the coronary circulation and correction of the myocardial imbalance Since angina pectoris is predominantly due to sclerosis of the coro-



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nary vessels, it is unlikely that such a procedure has any lasting value For definitive therapeutic effect, it is necessary to inject the ganglia and rami with alcohol or phenol or remove them surgically

The use of paravertebral alcohol blocks for the symptomatic treatment of angina pectoris constitutes one of the most brilliant chapters in the history of nerve block therapy During the past quarter of a century, they have played the major role in the man agement of patients with severe cardiac pain not re lieved by medical means The efficacy of this method is too well known to warrant further discussion A recent review of the literature revealed that over 500 case reports have been published of which slightly more than 75% showed satisfactory results while the mortality rate was less than 5% (104) A similar analysis of reported cases treated by sympathectomy revealed that the operation was effective in about 85% of the patients while the mortality rate ranged from 7% to 14% It is apparent that paravertebral alcohol block compares favorably with operation, particularly in view of the fact that many of the patients who were treated with blocks were in such poor physical con dition that operative intervention was contraindicated I am not suggesting that blocks should be performed in all cases On the contrary, it is my firm belief that with recent advances in surgery and anesthesia, most patients with intractable angina pectoris can withstand surgical section which is more specific, provides longer lasting relief and is generally better However, in patients who because of very advanced coronary dis-ease with angina decubitus, syphlitic aortitis (which markedly increases risk of death on the operating table), impending cardiac decompensation, or rheu

matic fever with severe regurgitation, are extremely poor surgical risks and in the very old patients who cannot be kept in bed, alcohol blocks constitute an excellent substitute method

Aneurysm and Other Painful Conditions of the Aorta

The same reasoning may be applied to the management of severe, intractable pain of aortic aneurysm and other disorders of the large vessels After diagnostic-prognostic blocks, the patient should have the benefit of sympathectomy or rhizotomy, unless he is an extremely poor risk, in which case alcohol blocks should be done

A number of French authors (46) have advocated the use of repeated injections of the preaortic plexus for cardiac and aortic pain Since my experience with this method is limited, I am not in a position to give an authoritative opinion regarding its value

Acute Myocardial Infarction

One of the most important clinical uses of cervicothoracic sympathetic blocks is to provide prompt relief in patients with severe, intractable pain consequent to acute myocardial infarction The patient is not only made comfortable, but the strong emotional stress, anxiety, and sense of impending dissolution are eliminated and reflex coronary spasm and other viscero visceral, visceromotor and viscerosensory reflexes are interrupted

Paravertebral alcohol blocks or sympathectomy have been used by Flothow (105) in treatment of patients with congestive failure that did not respond to usual medical therapy He believed that the benefit was

derived from the maximal coronary vasodilation produced by the block In the few patients in whom I have used this method, the results were far from impressive, and I cannot recommend its use

Cardiac Arrhythmia

The successful use of cervicothoracic block in the management of intractable paroxysmal tachycardia and other disturbances of cardiac rhythm due to emotional and neurogenic factors has been reported (37) Our results with this method in five patients have not been impressive since only two derived benefit from it This was probably due to the fact that the block was restricted to one side These results, together with those reported in the literature suggest that if a unilateral block is not successful in stopping the disturbance in rhythm, then a bilateral block should be performed with a very short acting local anesthetic drug, such as Nesacaine If the arrhythmia is temporarily eliminated, the block should be repeated on two occasions as prognostic tests and then the patient should be subjected to bilateral thoracic sympathectomy (95) In very poor risk patients, injection of neurolytic agents, such as phenol or alcohol may be tried as a substitute to operation

Pulmonary Disease

Pulmonary Embolism

In our experience as well as that of others (49, 106), cervicothoracic sympathetic blocks have been effective in providing prompt relief of pain, dyspnea, orthopnea and cyanosis in patients with pulmonary embolism, when the block has been done soon after the attack Leriche (40), who was the first to suggest

this method, believes that the benefit produced results from blocking of the pain and reflex spasm of the pulmonary and coronary blood vessels. Of course, the pleuritic pain due to pulmonary infarcts can only be relieved by intercostal blocks.

Intractable Asthma

A large number of authors (47, 107) have reported cures with repeated blocks or alcohol blocks of the stellate ganglion in patients with intractable asthma. Although admittedly the bronchoconstrictor fibers are carried by the vagus nerves, sympathetic block interrupts the afferent limb of the reflex arc involved in the attacks. In our clinic, this procedure has produced equivocal results and on this basis cannot be recommended. Interruption of the vagus would appear to be more sound physiologically.

Intractable Cough and Pulmonary Pain

Block of the vagus nerves may be used prior to surgical section as a prognostic procedure in patients with severe, intractable cough and pain due to malignant lesions of the tracheobronchial tree. It is necessary to carry out this procedure with caution since it usually involves other cranial nerves.

Other Pulmonary Disorders

European writers have reported beneficial effects from cervicothoracic sympathetic block in the management of acute pulmonary edema and bronchial hypersecretions and in the treatment of tuberculosis, bronchial pneumonia and other pulmonary infections (47). Since I have not used this block for these pur-

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since it provides not only sympathetic interruption but also analgesia, and it may be continued for several days

ABDOMINAL VISCERAL DISEASES

Sympathetic blocks have been used for a number of years as diagnostic, prognostic and/or therapeutic procedures in a variety of abdominal visceral disorders In patients with *chronic pain syndromes* of the lower esophagus, stomach, intestines, biliary organs, pancreas, or any other abdominal viscus, in whom sympathectomy is contemplated, it is advisable to determine preoperatively by means of nerve blocks the segments that transmit the pain and whether or not somatic nerves of the parietal peritoneum are also involved In such instances it is essential to limit the amount of solution to 2 to 3 ml lest it diffuses to adjacent segments and thus produces misleading results

In selecting patients with *achalasia* and *cardiospasm* for surgical treatment directed at denervating the cardia, it is important to differentiate with prognostic nerve blocks between true cardiospasm and hypertrophic stenosis It should be mentioned, in passing, that the results with sympathectomy have not been impressive, and it is today generally agreed that direct surgical procedures on the structure involved are far more effective The same may be said regarding pylorospasm and functional spasm of other sphincters Diagnostic prognostic blocks are also of value in neurogenic intestinal obstruction and megalocolon In both of these conditions, these procedures may produce lasting benefit

Paravertebral sympathetic block has been used as a diagnostic and prognostic procedure in selecting pa-

poses, I cannot give an opinion, but it seems very unlikely that such a procedure would produce more than a placebo effect. In Moore's experience, this procedure has proved useless for these measures and other disorders of the chest (107).

Other Disorders of the Chest

Cervico-thoracic sympathetic blocks are sometimes effective in reducing the pain and the edema associated with the *postmastectomy syndrome* and in increasing the function of the arm by decreasing contractures of scars (47, 108). In order to obtain optimal results, it is necessary for the patient to use the arm actively and to keep it elevated whenever she isn't using it. Blocks should be repeated every 4 to 5 days. A neurolytic agent may be used if the results with the temporary blocks warrant prolonged interruption.

Paravertebral sympathetic block has been advocated as an effective adjunct in the management of the severe pain of *acute herpes zoster* (109). It has been suggested that the nerve block not only relieves pain, but ameliorates the physiopathologic process and thus shortens the duration of the disease and decreases the incidence of postherpetic neuralgia, but evidence that such is the case is lacking. Moreover, it should be stressed that since pain in this condition is usually not severe, and since certain hazards are inherent in these blocks, they should be reserved for the unusual patients who experience severe pain. For optimal results it is necessary that the blocks be instituted promptly and continued for several days. Neurolytic agents should be avoided in such cases since the chemical neuritis may aggravate the symptomatology. If it is feasible, continuous epidural block is the procedure of choice

otomy, and it is to be preferred if the disease is limited to the viscera and is not likely to spread to the ab dominal wall and involve somatic nerves in the parietal peritoneum or pleura It is obvious, therefore, that diagnostic prognostic blocks must be executed and interpreted with skill if they are to be useful in helping the neurosurgeon select the procedure of choice

Therapy of Painful Abdominal Disorders

Patients with severe, intractable abdominal pain, due to disorders for which surgery is not indicated or must be postponed, can be afforded complete relief with various types of nerve blocks which interrupt pain and sympathetic pathways If the disease is a self-limiting condition which requires block for only several days, repeated or continuous technics with local anesthetic drugs are advisable On the other hand, if the condition is chronic or intractable, it will be necessary to effect either chemical interruption or surgical excision of the sensory and sympathetic nerves to the viscera If the pain is entirely due to visceral disorders without involvement of the abdominal wall, interruption of the splanchnic nerves should provide complete relief

Acute Pancreatitis

It is now generally agreed that block therapy is the best method of controlling the excruciating pain of *acute pancreatitis* (5, 12, 44, 110, 119, 122) This method is particularly valuable in patients in whom pain cannot be relieved with large doses of narcotics even when these are administered intravenously Some writers suggest that in addition to providing the much needed relief, the block decreases the severity and duration of the disease by interrupting the reflex

tients with *abdominal pain of unknown origin* for possible neurosurgical intervention White and his associates (95) report that this method has led to a number of brilliant results after all other forms of medical therapy and numerous ill advised abdominal operations have failed The writer is prompted to warn once again against the impropriety of making de ductions from the results obtained from blocks with out recourse to other clinical evidence Many of these patients require a detailed study, including a neuro logic examination and laboratory tests For proper interpretation of results, it is necessary to have a very accurate knowledge of the mechanisms of referred pain The results obtained with paravertebral block of the visceral sensory pathways should be repeated and verified on several occasions, and perhaps cor roborated with the results obtained with segmental epidural or subarachnoid block

In using paravertebral block of thoracic segments, it should be remembered that the procedure frequently involves not only the sympathetic and visceral afferent components but also the somatic fibers which supply the abdominal wall, because the solution frequently spills to the spinal nerve This is a particularly im portant consideration if the block procedure is being employed to predict the effects of splanchnicectomy or to help select other neurosurgical procedures Of course pain in the viscera themselves is entirely elimi nated if the visceral afferent fibers, which run in the sympathetic trunks, are correctly blocked Moreover, relief is sure to follow resection of these structures or their destruction with alcohol without concomitant analgesia of the abdominal wall This procedure has obvious advantages over extensive rhizotomy or chord

mechanism that contributes to the disturbed physiology It is said that the sympathetic block combats reflex spasm of the duodenum, sphincter of Oddi, and the entire ductal system so that there is rapid release of the extraductal pressure and an emptying of the toxic fluid from the extrabiliary and pancreatic ductal system It is said too that the block relieves the visceral vasospasm which also contributes to the deranged physiology, but proof that such is the case is lacking The procedure definitely inhibits reflex ileus which frequently complicates acute pancreatitis The block may be produced by individually injecting the sympathetic ganglia, by splanchnic block or peridural injection We prefer continuous peridural block because it provides prompt and complete relief, since it not only interrupts the sympathetic and pain fibers to the pancreas, but also the somatic pain nerves of the parietal peritoneum which are frequently involved by the chemical peritonitis

Acute Cholecystitis

Therapeutic blocks have been also used with success in relieving the pain and smooth muscle spasm and reducing the inflammatory process of uncomplicated *acute cholecystitis* (111) However, this procedure should be considered merely as a temporary measure and reserved for patients who have severe, intractable pain which cannot be relieved with narcotic analgesics In such instances, continuous epidural block is preferable because in addition to providing temporary relief during the preoperative period, it can be extended to provide surgical anesthesia for the operations

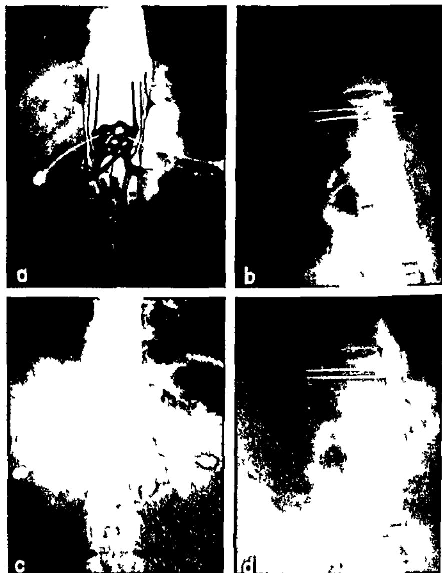


Figure 21 Roentgenograms showing needles in place for injecting the celiac plexus and splanchnic nerve (A) Anterior posterior view with a drawing of the ganglia superimposed (B) Lateral view with both needles in place (C) and (D) Diffusion of 10 cc of 35% Diodrast injected through the right needle In (A) and (C) note the relationship of the needles to the 12th rib and the 1st lumbar vertebra (Bonica *Management of Pain* Courtesy Lea & Febiger)

being prepared for surgery Continuous peridural block is to be preferred because it can be extended to the operative period for surgical anesthesia

Chronic Abdominal Pain

In poor risk patients with severe pain due to chronic pancreatitis postcholecystectomy syndrome, idiopathic nephralgia, or any other disorder of the abdominal viscera splanchnic block with alcohol or phenol may be considered as a substitute for sympathectomy Of course in all these conditions it is necessary to be certain of the diagnosis and to predict the effects of prolonged block with a temporary block It should also be stressed that in most of these patients splanchnicectomy is a much better procedure than chemical sympathectomy

Pain due to malignancies of the abdominal viscera is rarely permanently relieved with chemical or surgical sympathectomy because it invariably spreads to involve somatic nerves Occasionally, however, the physical condition of the patient and other circumstances indicate alcohol block of the splanchnic nerves or the celiac plexus in the treatment of cancer of the liver pancreas, spleen, or other viscera which do not involve the abdominal wall In the event of subsequent spread, the somatic nerves can then be blocked either by paravertebral, intercostal or subarachnoid injection

Abdominal pains, the cause of which cannot be determined even by exploratory laparotomy, may require sympathetic ganglionectomy or splanchnicectomy for relief Following test blocks with local anesthetic, chemical sympathectomy may be a wise choice in some of these cases particularly if the patient s condition is poor

Block of the appropriate sensory pathways is also a very valuable procedure in managing acute, severe biliary colic Again it should be stressed that this method should be reserved for those patients who can not be controlled with more conservative measures

Ureteral Colic

Paravertebral block of the splanchnic nerve and 1st and 2nd lumbar ganglia may be used in controlling severe ureteral colic In a significant number of patients with this disorder treated in our clinic, the block *not only relieved the pain completely, but also relaxed* the ureter sufficiently to permit advance of the stone to a point where it could be removed through a cystoscope, thus obviating an open operation Continuous segmental epidural block is the procedure of choice in these cases

Other Acute Disorders

French and Italian writers have reported the successful use of sympathetic block in the treatment of *acute orchitis and salpingitis* (12, 34, 40, 46) In the few cases tried in our clinic, the results have been equivocal and, therefore, I cannot recommend the procedure

Paravertebral block of the lumbar sympathetic chain with large volumes has also been used in the diagnosis and treatment of *dysmenorrhea* Presacral neurectomy produces better results

Occasionally blocks may be indicated during the preoperative period in patients with severe, *intractable pain* due to surgical disorders, such as ruptured peptic ulcer, in order to afford the patient relief while he is

have had no experience in the use of nerve blocks in either of these conditions, and cannot render an opinion concerning their value However, the fact that no confirmative reports have been published, indicates that this method is not very effective

Sympathetic interruption induced by block of paravertebral ganglia splanchnic nerve, or celiac plexus, or by the peridural method, is of considerable value in the management of severe paralytic, acute ileus I have encountered three patients who were moribund as a direct result of extreme degrees of ileus, but who made remarkable recoveries following a block carried out continuously for several days

I have used continuous sympathetic block with beneficial effects in patients with reflex anuria, and also in an attempt to control the hypertension associated with preeclampsia or eclampsia Nerve block technics can be used as a temporary therapeutic measure to great advantage in severe hypertensive crises when a quick effect is desired, and as a means of improving the condition of the patient for the operation In some patients properly executed blocks may be lifesaving

Diseases of the Urinary Bladder

Block of the 3rd and 4th sacral (parasympathetic) nerves is a valuable adjunct in the management of certain patients with urinary retention due to paraplegia These procedures are particularly valuable as diagnostic prognostic measures in predicting the effects of alcohol block or transsacral rhizotomy which are considered as the definitive therapy in such cases (114)

Paravertebral sympathetic block of the lower lumbar

A number of European clinicians have reported the successful use of bilateral splanchnic block in the treatment of the visceral crisis of tabes (37) My experience together with reports from other clinics prompts me to state that this procedure is useless and that chordotomy is the method of choice

Aneurysm of the abdominal aorta is sometimes the basis of severe, persistent, epigastric pain radiating to the back Surgical excision and replacement is the treatment of choice, but if this cannot be carried out, paravertebral block, first with local anesthetic drugs and later with alcohol, may be considered

Therapy of Nonpainful Visceral Disorders

A number of abdominal disorders due to autonomic imbalance have been treated with autonomic interruption with varying success It has already been mentioned that patients with congenital magacolon or neurogenic intestinal obstruction may derive prolonged benefit from temporary sympathetic interruption Although some writers (5, 12) have advocated the use of alcohol splanchnic block for the therapy of peptic ulcer in an effort to improve circulation and enhance healing, this method cannot be considered seriously in view of recent developments in the treatment of this disease The same may be said of the use of this method as suggested by a number of European authors (12, 112) in treating diabetes mellitus

Ochsner and his associates (17 113) have successfully treated a number of patients with fibrocystic disease of the pancreas by splanchnic block and/or splanchnicectomy Luzuy (34) reported a number of cases of pylorospasm in infants treated with repeated sympathetic nerve block with excellent' results I

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segments has been advocated in the treatment of severe pain associated with cystitis and other bladder disorders Perhaps these measures may be used as prognostic procedures to predict the effects of sympathectomy when such an operation is being considered However, in most instances it will be necessary to block the 2nd, 3rd and 4th sacral nerves which carry the sensory fibers from the bladder We have used this procedure with beneficial results in several patients with severe vesical spasm accompanied by excruciating pain due to cystitis Continuous block by the caudal route is more practical

Miscellaneous Indications for Sympathetic Block

Sympathetic block has been advocated as an adjunctive measure in the management of *cancer pain* in patients who experience a diffuse, burning discomfort along with the severe, intractable pain In such cases, it is necessary to interrupt the involved sympathetic pathways *in addition to the somatic nerves in* order to obtain complete relief As previously mentioned, sympathetic blocks are also frequently employed as adjuncts to somatic nerve block in the treatment of myofascial and other musculoskeletal disorders

Extensive vasomotor block has been employed as a prognostic measure in selecting patients with hypertension for sympathectomy It is hardly necessary to point out that this should be considered as only one of the many preoperative tests which can be used for this purpose Moreover, it should be emphasized that while the block is useful in predicting the immediate effects of the operation, the long term effect of sympathectomies does not correspond with these results

Beneficial effects follow sympathectomy even in patients in whom the operation fails to produce a lowering of the blood pressure

CHAPTER X

BLOCK OF SPINAL NERVES

(Somatic Nerve Block)

REGIONAL BLOCK of one or more of the 31 pairs of the symmetrically arranged spinal nerves may be used as a diagnostic, prognostic and therapeutic measure in the management of many disorders The interruption may be carried out at various points along the course of the nerve or nerves from their attachment to the spinal cord to their very termination in the tissues, as depicted in figure 22 Since subarachnoid and extradural block will be discussed in subsequent chapters, the present discussion will be limited to block of spinal nerves distal to the intervertebral foramina Although such procedures are frequently called somatic nerve blocks to distinguish them from a pure autonomic (sympathetic) nerve block, as is well known, formed spinal nerves contain sympathetic or parasympathetic fibers as well as somatic sensory and somatic motor neurons

Block of the spinal nerves is usually employed primarily to interrupt sensory but particularly pain pathways in the management of severe, acute or chronic pain Less frequently it is employed to block nerve supply to skeletal muscles to control skeletal

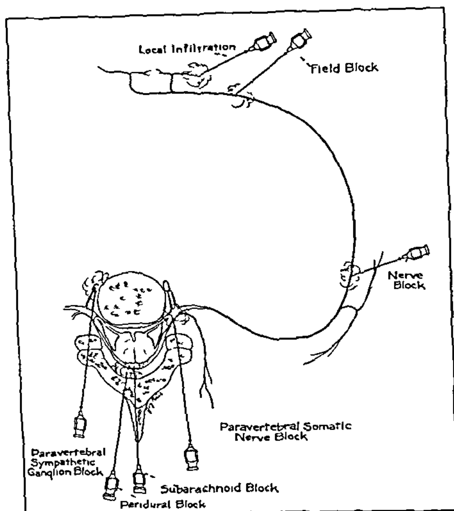


FIGURE 22 Various sites where a typical (thoracic) spinal nerve may be blocked (Bonica *Management of Pain* Courtesy Lea & Febiger)

muscle spasm Thirdly, since the mixed nerves to the extremities contain sympathetic fibers, regional block of these structures is employed to effect sympathetic interruption as a complement to paravertebral sympathetic block or in order to confirm the results obtained therefrom Obviously then block of spinal

nerves can be employed in the management of neuralgia, causalgia and other reflex dystrophies, musculoskeletal pain, pain due to cancer and other neoplastic disease, and also painful conditions of the skin, subcutaneous tissue and fascia However, as it will be stressed, in many of these conditions pure sympathetic block, or extradural block, or subarachnoid block may be preferred, and block of the spinal nerves may be considered secondary in importance

Before proceeding with the discussions of the various technics of blocking the spinal nerves, some general comments concerning neuralgia and cancer pain should be made

Neuralgia

Neuralgia is frequently used by both medical and lay public interchangeably with neuritis, radiculitis and neuropathy In this monograph the use of this term is reserved to the literal connotation — painful sensation in the region of one or more of the spinal or cranial nerves Neuralgia is the symptomatic expression of a neuropathy, radiculopathy, or myelopathy, which is usually a result of inflammatory, circulatory, toxic, degenerative, metabolic or neoplastic disturbances Not infrequently it signals organic disease and for weeks, months, or years may be the only manifestation of the pathologic process Sometimes it is the expression of some systemic infection, nutritional deficiency or other constitutional disturbance, which for some unkown reason, has a selective affinity for a specific nerve or nerves Occasionally, neuralgia constitutes the entire clinical syndrome without any apparent etiologic basis or structural changes, as occurs in tic douloureux

Very rarely neuralgia may be a symptom of thalamic pain and other central pain disorders

It is very obvious that to treat neuralgia properly it is most important to ascertain the cause and remove it, if possible The essentiality of adhering to this most important basic principle cannot be overemphasized This is a requisite particularly important to the physician who employs nerve block as a method of management for it is all too easy to employ this method wrongly so that the patient and everyone concerned in his management may be misled into carrying out a disastrous measure On the other hand, in patients in whom it is not feasible to eliminate the cause, and there is great need of providing the patient with symptomatic relief, nerve blocks of the appropriate pathways may be used to advantage to help to make the diagnosis, to help predict the effects of a more definitive interruption, such as neurosurgery or alcohol injection, and to help in the treatment of the neuralgia

Cancer Pain

Block of sensory nerves has particular usefulness in the management of cancer pain Although this method has certain limitations, it has more to offer than narcotic analgesics and should be employed as a complement to these drugs, and/or neurosurgery (15, 16) Effective blocks produce adequate relief of pain, enable the sufferer to receive more intensive radiation therapy and other forms of medical treatment which otherwise could not be tolerated When properly carried out and effective, nerve blocks are not accompanied by the depression of respiration, circulation, gastrointestinal function and other visceral disturbances inherent in narcotic therapy In patients whose

physical condition contraindicates neurosurgical interruption, proper application of nerve blocks with neurolytic agents can be considered as a good substitute for the more major procedure

The selection of the appropriate technic depends upon the location and nature of the pain, the type of neoplasm and its grade of differentiation, and the structures it might invade (49) It is essential that a block procedure is selected which will afford sufficient widespread analgesia to obviate repeated attempts One of the most important factors in the selection of the optimal technic is to consider the mechanisms producing the pain, which may be caused by

(1) Compression of nerve roots nerve trunks or plexuses by the tumor or compression by metastatic fracture of bone adjacent to the nerves resulting in mechanical radiculopathy or neuropathy which is accompanied by sharp well localized projected pain typical of neuralgia

(2) Infiltration of the nerves and blood vessels by tumor cells resulting in a perivascular and perineural lymphangitis and consequent irritation of the sensory nerve endings producing a diffuse burning pain

(3) Obstruction of a viscus particularly the gastrointestinal and genitourinary tract with consequent production of true visceral pain which is characteristically dull, diffuse and poorly localized

(4) Occlusion of blood vessels either partial or complete by an adjacent tumor producing venous engorgement or arterial ischemia or both

(5) Infiltration tumefaction and swelling in tissues invested snugly by fascia periosteum or other pain sensitive structures

(6) Necrosis infection or inflammation of pain sensitive structures produced by contiguous tumors

It should be again stressed that this method should be reserved for patients who are in poor physical condition, or those who have such rapidly growing tumors that the life expectancy is considered to be only a few weeks or less than two months Moreover, in order to

obtain optimal results it is necessary to integrate this method with other forms of treatment Palliative procedures such as by pass operations in the gastrointestinal tract, radiation therapy, castration, the administration of endocrines nitrogen mustard, and radioactive compounds, bilateral adrenalectomy and other procedures which temporarily eliminate the cause of the pain, first must be tried in indicated cases The relief of pain accompanying these measures is often dramatic and represents a gain in time and courage It is only when these measures fail or are not feasible that the symptomatic control of pain with narcotics, nerve blocks and/or neurosurgery should be considered

Although a discussion of narcotic analgesia is beyond the scope of this monograph, I cannot avoid making a few comments concerning their use While the proper use of these drugs can be considered of great value and a true blessing to patients with cancer pain, the simplicity of their administration and their inexpensiveness — desirable qualities of any drug — frequently favors their misuse It should be remembered that narcotics while effective in making pain more bearable for the patient, never really abolish it Moreover, they produce depression of respiration, and of gastrointestinal and other visceral functions The attitude of some physicians to 'snow the patient under because the end is inevitable' denotes a lack of understanding of the problem and may be productive of unnecessarily premature tolerance, thus precluding relief for the patient in the latter stages of the disease even with massive doses of narcotic drugs Therefore, it is essential to consider the early use of some method of interrupting pain pathways which makes possible the

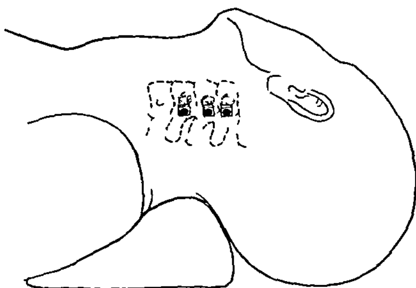
postponement of narcotic therapy and consequent development of tolerance until near the end.

Patients who have been on prolonged narcotic therapy and require large amounts of these drugs at the time the block or neurosurgery is carried out, are likely to develop marked respiratory depression, or even apnea, when the stimulus of the severe pain is suddenly eliminated. Obviously, the respiration must be carefully observed during and immediately after the procedure is carried out.

A BLOCK OF CERVICAL SPINAL NERVES

Paravertebral Block

Paravertebral block of one or more of the eight cervical nerves is occasionally employed in controlling severe neuralgia, headache, muscle spasm in the neck region, and other disorders involving structures supplied by these nerves. Before these clinical applications are considered, it needs to be mentioned that certain complications may result following the use of this method. Paravertebral block in any segment is inherent in the serious hazard of accidental subarachnoid injection. This complication is especially serious in the cervical region because it will inevitably involve the phrenic nerve and perhaps the upper intercostal nerves and even the respiratory center with consequent respiratory insufficiency or paralysis. Moreover, general toxic reactions occur more frequently following paravertebral block in this region probably because of the great vascularity of the neck. Other complications which may occur include concomitant block of the cervical sympathetic nerves with development of



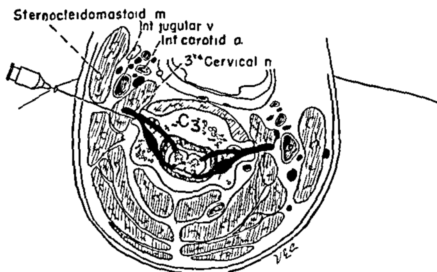


FIGURE 23 *Technic of paravertebral injection of cervical nerves* Upper figure illustrates the position of the patient Note that the head is turned to the opposite side and the patient has a small pillow under the upper portion of the thoracic spine and neck in order to make the transverse processes of the cervi

(Continued on next page)

Horner's syndrome and involvement of the superior and recurrent laryngeal nerves, and perhaps even the trunk of the vagus All of these can be avoided by using proper technic and small volumes of solutions

In carrying out paravertebral block in patients with neuropathy, it is essential to avoid contact with the nerve lest the needle aggravate the edema and other pathologic processes Infiltration in the general region of the nerve is sufficient In addition to relieving the pain and muscle spasm, the local anesthetic produces vasodilatation of the region and may thus enhance reversal of the neurologic process Alcohol should never be employed except in patients with inoperable neoplastic disease or in the unusual patient with arthritis or other chronic organic disorders which are producing severe pain that cannot be managed in any other way

Neuralgia

In young people neuralgia is usually due to injury which produces a subluxation of the cervical spine with consequent mechanical neuropathy, or herniation of the intervertebral disc Subluxation or dislocation is especially important in the upper cervical spine because the peculiar articulation of the upper two cervical vertebra make the nerves vulnerable to trauma as

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cal vertebrae more prominent The tips of the transverse processes are palpated and skin wheals are formed at these points Each needle then is inserted perpendicular to the skin until the nerve is contacted Lower figure shows the needle in place with its tip near the 3rd cervical nerve on the left For diagnostic and prognostic blocks it is advisable to contact the nerve and elicit paresthesia prior to injecting 2 to 3 ml of solution

they lie upon the vertebral arches of the axis and the atlas instead of occupying intervertebral foramina The posterior division of the second nerve, which becomes the greater occipital nerve, is particularly liable to such injury, resulting from direct trauma to the head, or as a whip lash received when a car is struck from the rear by another automobile

These posttraumatic disorders produce a mechanical neuropathy with consequent neuralgia in the distribution of the greater and lesser occipital nerves and frequently associated muscle spasm Most of these conditions are managed with conservative treatment consisting of traction, physical therapy and analgesics Paravertebral nerve blocks have a limited usefulness as an adjunct to control severe pain, although occasionally the block interrupts a vicious circle and thus produces prolonged benefit Nerve blocks may also be used as a diagnostic procedure to determine which nerve is affected For such purposes the volume must be limited to 2 to 3 ml lest the solution diffuses to involve adjacent nerves

Neuralgia in the lower cervical region, usually called cervicobrachial neuralgia, in young people is frequently due to injury with consequent partial or complete herniation of the intervertebral disc, or perhaps a mild subluxation which produces root sleeve fibrosis Occasionally injury produces stretching or partial tear of nerve roots or nerves, or fracture of the vertebrae with consequent compression of the nerve These conditions are manifested by neuralgia and frequently by a reflex muscle spasm which contributes to the physiopathology Treatment usually consists of traction and physical therapy, and paravertebral blocks are used only to relieve severe pain and muscle spasm

In older patients occipital and cervicobrachial neuralgia are due to osteophytes and other vertebral pathology secondary to arthritis In addition to the pain *which may be severe and may be local as well as neu*ralgic, there is usually reflex muscle spasm In such patients blocks are also reserved for the control of very severe *pain and muscle spasm*

Headache

Paravertebral block of the upper cervical nerves may be employed in the treatment of the so-called rheumatic or indurative headache and posttraumatic and postconcussion headache Indurative headache is an ill defined condition associated with tenderness in the muscle and fascia in the suboccipital region and is thought to be due to fibrositis It is usually seen in elderly individuals and may be related to arthritis Frequently there is tenderness in the muscle and fascia which leads one to suspect that perhaps this might be a chronic myofascial syndrome In any event, the condition can be markedly relieved with paravertebral injection Some patients respond with prolonged symptomatic relief after several such injections are carried out

Posttraumatic headache may be a mild occipital neuralgia secondary to vertebral pathology, or it might be part of the postconcussion syndrome The latter term is reserved for those patients who present a history of injury to the cranium followed by unconsciousness and subsequently complain of headache, dizziness, or both, without evidence of fracture to the skull or other neurologic findings In either case the headache is frequently accompanied by severe muscle spasm Repeated paravertebral injection with Ponto

caine or Nupercaine may effect long lasting relief Some have reported periarterial infiltration of the principle arteries of the scalp as the best method of treatment (44) It is of course essential to be certain of the diagnosis before block therapy is considered

Musculoskeletal Disorders

Occasionally subluxation, dislocation, fracture, arthritis, and other musculoskeletal disorders produce a severe localized pain which can be relieved with simple local infiltration On the other hand, if this proves ineffective, or the pain is widespread and is associated with extensive muscle spasm, paravertebral injection should be carried out

Spasm of the suboccipital and other muscles of the neck may represent a reflex disturbance caused by diseases of the eyes, nose and paranasal sinuses, and other lesions of the face (49, 115) This reference can be explained by the fact that these structures are supplied by the upper cervical segments of the spinal cord which are in close relation to the spinal tract and nucleus of the trigeminal nerve Even more frequently spasm of neck muscles is psychogenically induced and is a manifestation of tension In either case, it becomes a new source of noxious stimulation which produces pain and aggravates the physiopathology For this reason it is necessary to eliminate the muscle spasm with block in the form of local infiltration or paravertebral injection of the cervical nerves Dilute solutions of Pontocaine or Nupercaine are best for this purpose The use of Medco Sonlator in conjunction with the blocks enhances their effects

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course, the cause of the pain cannot be eliminated and more conservative measures have failed

Phrenic Nerve Block

Block of the phrenic nerve is primarily indicated in the management of intractable hiccoughs The block affords temporary respite and occasionally produces prolonged relief by breaking up the vicious circle It may also be used to manage pain in the structures supplied by sensory fibers of the phrenics These include pericardium, diaphragmatic pleura and peritoneum, the inferior vena cava, suprarenal gland, and occasionally the gallbladder

The simplest method of blocking the phrenic nerve is by injecting the solution anterior to the scalenus anticus muscle approximately 3 cm above the clavicle Unfortunately, anatomic variations in the position of the nerve, together with frequent presence of accessory nerves and the many complex fascial structures in this region, are factors which cause a relatively high percentage of failure The use of dilute solutions of Xylocaine or other local anesthetic drug with high penetrance helps to decrease the incidence of failures A paravertebral block of the 3rd, 4th, and 5th cervical nerves may be used as an alternative technic

Caution must be exercised in using this technic in patients with pulmonary disease or a fixed thoracic cage or both, especially if a bilateral block is needed It is best to first use a drug which produces a block of short duration, and if the patient does not experience any respiratory difficulties, the block is repeated with a longer lasting agent as frequently as is necessary to control the hiccoughs or pain

Cancer Pain

Neoplastic lesions in the occipital region, neck, supraclavicular region, or upper extremity may indicate paravertebral blocks for the relief of severe intractable pain Cancer of the skin and other soft tissue in this region may progress to ulceration, particularly after x ray therapy and may be the cause of severe pain which often fails to respond to conservative managements This may also be the case of pulmonary sulcus or Pancoast tumor, which is a frequent cause of severe pain in the medial side of the upper extremities In such instances paravertebral block should be considered A prognostic injection with local anesthetic drug is first carried out and then alcohol For best results the alcohol should be injected in very close proximity of, or into, the nerve

Occipital Nerve Block

Block of the greater and third occipital nerves just above the superior nuchal line may be used in the treatment of occipital headache, neuralgia, and cancer pain of the posterior portion of the head Curiously enough, this procedure is frequently effective in relieving neuralgia due to vertebral pathology or disorders in the soft tissues of the neck proximal to the point of injection In view of the fact that occipital nerve block is simpler than paravertebral injection, it may be tried first

A long, 25 gauge needle attached to a 5 cc syringe is used, and it is not necessary to form a skin wheal Injection of 2 to 4 cc of solution is usually sufficient In severe, intractable, chronic pain, it may be deemed advisable to inject the nerve with alcohol, provided, of

course, the cause of the pain cannot be eliminated and more conservative measures have failed

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Block of the Brachial Plexus

The simplicity and facility of carrying out brachial plexus block, together with the fact that with proper technic it is successful in a very high per cent of cases makes this procedure one of the most useful methods not only for surgical anesthesia, but also as a diagnostic, prognostic, and therapeutic measure Since the brachial plexus contains all of the sensory fibers for the upper extremity (except for the skin of the deltoid

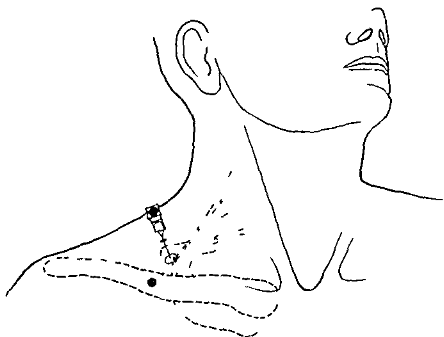


FIGURE 24A A Diagram depicting *brachial plexus block* by the supraclavicular technic The skin wheal is formed about 1 cm above the midpoint of the clavicle and the needle inserted in a downward backward and slightly inward direction until paresthesia is elicited indicating contact with the plexus The needle is inserted three different times as shown in Figure 25B Please note that at the point of injection the rib extends in an anteroposterior direction

region and the medial aspect of the upper arm) it may be employed to control severe brachial neuralgia and severe posttraumatic, or postoperative pain Occasionally, it is used as a temporary measure to control severe pain due to an extensive neoplastic lesion in the upper extremity or the shoulder

Since all of the sympathetic fibers destined for the hand, forearm, and lower two-thirds of the arm are carried by the nerves derived from the brachial plexus, block of this structure is a most effective measure to produce concomitant vasodilatation and analgesia in peripheral vascular disorders, causalgia and other sympathetic reflex dystrophies It is very useful to ascertain the degree of vasospasm and thus correlate the results of cervicothoracic sympathetic block It may be employed effectively as a diagnostic and prognostic measure in patients with phantom limb pain and other types of post amputation pain and in managing scalenus anticus syndrome and other costoclavicular disorders It may also be used to differentiate pain of peripheral origin from that caused by disorders of the central nervous system

One of the significant disadvantages of brachial plexus block, and also a drawback to blocking any somatic nerve which supplies an extremity, is the resultant muscular weakness or paralysis and the loss of proprioception and touch sensation which result in a practically useless limb Therefore, except in very extreme cases of patients with inoperable lesions that are producing severe, excruciating intractable pain, prolonged blocks with alcohol or any other neurolytic agents are absolutely contraindicated

In passing it should be mentioned that the most frequent serious complication of brachial plexus block

Block of the Brachial Plexus

The simplicity and facility of carrying out brachial plexus block, together with the fact that with proper technic it is successful in a very high per cent of cases makes this procedure one of the most useful methods not only for surgical anesthesia, but also as a diagnostic, prognostic, and therapeutic measure Since the brachial plexus contains all of the sensory fibers for the upper extremity (except for the skin of the deltoid

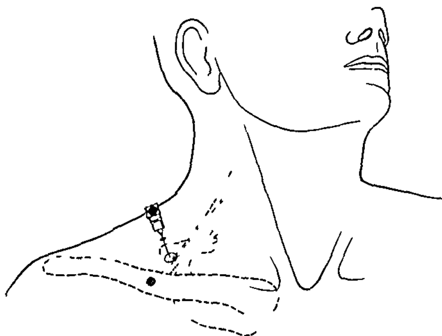


FIGURE 24A A Diagram depicting *brachial plexus block* by the supraclavicular technic The skin wheal is formed about 1 cm above the midpoint of the clavicle and the needle inserted in a downward backward and slightly inward direction until paresthesia is elicited, indicating contact with the plexus The needle is inserted three different times as shown in Figure 25B Please note that at the point of injection the rib extends in an anteroposterior direction

Subrascapular Nerve Block

Block of the suprascapular nerve, a branch of the brachial plexus and the major sensory nerve supply to the shoulder joint, is a very useful procedure for the management of pain in the shoulder It is especially indicated to control severe pain produced by bursitis, tendinitis, acute periarthritis, arthritis, and severe pain that follows injury or operations of the shoulder Suprascapular nerve block is usually reserved for those patients in whom local block therapy and intraarticular and periarticular injection of steroids fails to provide adequate relief As previously mentioned, when suprascapular nerve block is employed, it is frequently combined with cervicothoracic sympathetic block, as well as the other conservative measures

Suprascapular nerve block is accomplished at the suprascapular notch (Fig 25) Although in most instances this block is relatively simple, occasionally it is difficult to contact the nerve and the solution is injected within the muscle mass, resulting in failure In such instances, roentgenograms may be used to aid the placement of the needle Paralysis of the supraspinatus and infraspinatus results in some disability Pneumothorax is rare and may result from inadvertently advancing the needle too far anteriorly with consequent puncture of the lung

Block of the Median, Ulnar and Radial Nerves

The three major nerves which supply the upper extremity may be blocked with a single injection in the axilla or in the medial aspect of the uppermost part of

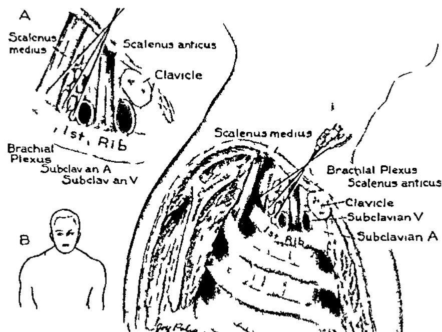


FIGURE 24B Sagittal section showing author s modification of *brachial plexus block* by the supraclavicular technic The first injection is made through the middle needle the second through the needle which has its point 1 cm anterior of that of the first needle and in immediate proximity to the subclavian artery and the third injection made through a needle which has its point 1 cm posterior to that of the first Injections are made when paresthesia is elicited in the course of advancing the needle from the skin to the 1st rib and also as the needle is withdrawn from the 1st rib to the skin 10 ml of solution is injected through each of the three needles thus creating a wall of anesthesia between the first rib and the skin through which the plexus must pass Insert A is an enlargement of the region *where the injection is done Note the relation of the plexus* to the 1st rib and the clavicle to the subclavian artery and vein and to the scalenus muscles (B) Indicates s te of sagittal section (Bonica *Management of Pain* Courtesy Lea & Febiger)

is puncture of the lung with consequent pneumothorax This does not create a serious problem except in patients with emphysema and other pulmonary diseases

orders of the hand, forearm and lower arm, as dis cussed under brachial plexus block

Any one of the three major nerves may be blocked

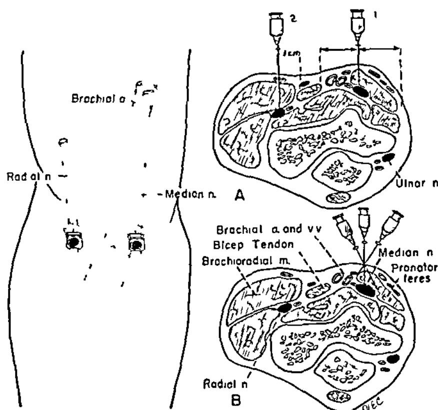


FIGURE 26 *Technic of blocking the median and radial nerves at the elbow* Figure on the left shows anterior view of antecubital fossa Note the relationship of the median nerve just medial to the brachial artery (A) Shows single injection technic used when paresthesia is elicited Note that the needle for median nerve block (1) is just medial to the vessel and at a point midway between the medial epicondyle and the medial edge of the biceps tendon and the needle for radial nerve block (2) is 1 cm lateral to the lateral edge of the biceps tendon (B) Shows fanwise injections used when no paresthesia is elicited for blocking the median nerve (After Bonica)

the arm, where they are in close relationship to the axillary and the brachial arteries Such a procedure may be used as a diagnostic, prognostic and/or thera peutic measure in the management of any of the dis

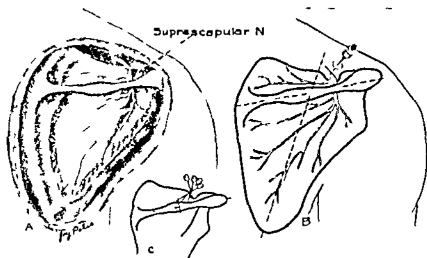


FIGURE 25 Anatomy and *technic of suprascapular nerve block* (A) Distribution of the nerve after it passes through the suprascapular notch underneath the superior transverse scapu lar ligament In addition to the muscular branches shown, the nerve supplies important branches to the shoulder joint and its periarticular tissues (B) Shows method of determining landmarks A line is drawn along the spine of the scapula and another one bisecting the inferior angle of the scapula The upper outer triangle formed by the intersecting lines is bisected and a wheal formed on this bisector about 1½ cm from the angle Through this wheal a 22 gauge 8 cm needle is intro duced so that a shaft directed slightly downward and medially to make contact with the supraspinatus fossa just lateral to the suprascapular notch The needle is then withdrawn and reintroduced medially until the point enters the notch to pro duce paresthesia The small inset in the center shows another method of locating the nerve inserting the needle in a fan wise fashion in order to locate the notch and the nerve (Bonica *Management of Pain* Courtesy Lea & Febiger)

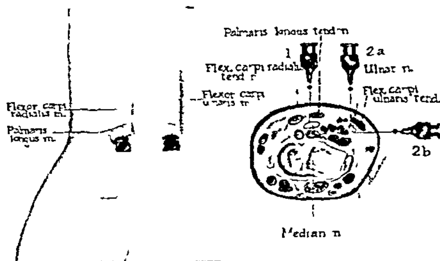


FIGURE 27 *Median and ulnar nerve block at the wrist* The figure on the left shows the sites of the skin wheal for median nerve block between the tendons of the palmaris longus and flexor carpi radialis and that for the ulnar nerve just lateral (radial) to the tendon of the flexor carpi ulnaris muscle The inset is a cross section showing direction of the needles (1) median (2a) ulnar block by anterior approach and (2b) ulnar block by the median approach. (Bonica *Management of Pain* Lea & Febiger)

B BLOCK OF THORACIC SPINAL NERVES

Paravertebral Block

Paravertebral block of the thoracic spinal nerves is a very useful procedure in managing many disorders involving the thoracic cage as well as the abdominal and thoracic viscera Since paravertebral block affects the entire formed spinal nerve, including the recurrent branch which supplies the vertebra and a segment of the meninges this procedure is useful in controlling severe pain due to vertebral and meningeal disorders

individually in the lower part of the arm, or at the elbow or wrist Above the lower third of the arm the median and ulnar nerves are in close proximity and therefore it is necessary to elicit paresthesia and to employ very small volumes in order to effect a specific block of either nerve Block of the radial nerve may be carried out on the lateral aspect of the arm as the nerve winds around the musculospiral groove between the medial and lateral heads of the triceps muscle

Specific block of each of the three nerves is best *carried out at the elbow or wrist Selection of either* site depends on the site of the lesion These technics are particularly useful as prognostic blocks to ascertain the degree of vasospasm in peripheral vascular dis ease In this connection it should be emphasized that there is a significant overlap of the three nerves in supplying the vessels to the fingers

I have used block of the three major nerves at the elbow and wrist with a concomitant subcutaneous in filtration to anesthetize the extremity distal to the block in controlling severe, intractable itching and other discomfort which is sometimes seen in dermatologic disorders By producing a block lasting for several hours the patient is afforded respite from the itching and is better able to control the urge to scratch In this way, the vicious cycle of itch scratch itch may be broken and a cure effected For best results, it is advisable to carry out a block in the evening just before the patient falls asleep, because it is during the night while the patient is asleep that he unknowingly scratches and worsens the skin lesions It is hardly necessary to em phasize that this is a method which should be reserved in treating severe, intractable cases

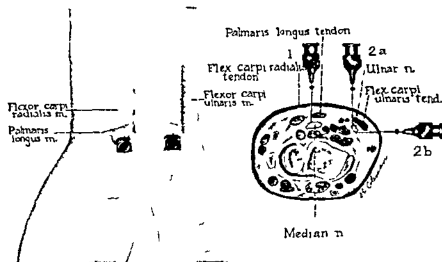


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When used as a diagnostic and prognostic procedure to determine the segments involved in the pain, an attempt should be made to contact the nerve, the amount of solution should be limited to 2 to 3 ml , and the position of the needles verified with roentgenograms Unfortunately, the standard technic of paravertebral somatic nerve block carries with it a high risk of pneumothorax I believe that this is due to the fact that with the standard technic the needle is inserted too far laterally and in order to reach the somatic nerve frequently traverses the deep concavity on either side of the vertebral column which contains the posterior border of the lung In order to minimize this danger, I have modified the technic, as depicted in Figure 28 It should be noted that the needle is advanced not more than 0 5 cm beyond the posterior surface of the lamina of the vertebra

Extensive thoracic paravertebral block is followed by vasomotor block with a consequent hypotension This complication may prove serious in elderly patients with arteriosclerosis In addition, extensive subarachnoid injection can occur if the solution is advertently injected into a dural cuff which sometimes extends beyond the intervertebral foramina

Neuralgia

Thoracic paravertebral block is useful in the management of infectious, posttraumatic and postoperative neuralgia of the chest In younger people segmental neuralgia is a sequelae of systemic infection or vertebral injury with consequent mechanical neuropathy In older patients this type of neuralgia is usually due to poor posture muscular decompensation, and consequent scoliosis, or it is due to arthritis and in very

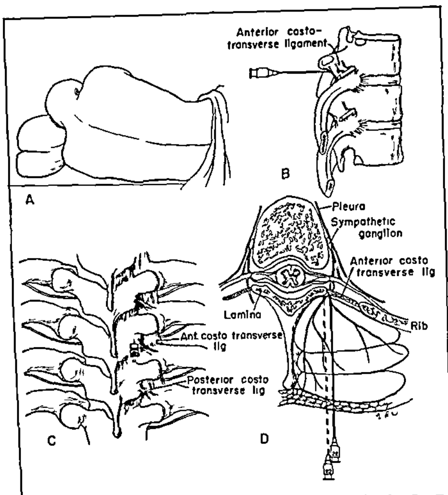


FIGURE 28 *Technic of paravertebral thoracic somatic nerve block* (A) Position of the patient for block on the right side Note that the skin wheal is formed 1½ cm lateral to the tip of the spinous process of the vertebra above as shown in (C) The needle is inserted perpendicular to the skin and advanced until the lateral edge of the lamina is contacted as depicted in insert The needle is then withdrawn until its point is in the subcutaneous tissue the skin moved laterally about ½ cm and the needle then readvanced until it slips just lateral to the lateral edge of the lamina until its point engages the transverse ligaments A syringe filled with local anesthetic solution is then attached to the needle and attempt is made to inject As

(Continued on next page)

old people osteoporosis with collapse of the vertebra and consequent mechanical neuropathy These conditions produce not only pain in the chest but reflex *muscle spasm and segmental hyperesthesia and hyperalgesia*

Definitive treatment of these conditions is a medical or orthopedic problem and block should be reserved only for those patients who experience severe pain Curiously enough, some of these patients derive prolonged benefit from block therapy, probably because the block also relieves concomitant reflex muscle spasm and other associated responses which frequently contribute and perpetuate the physiopathologic process (see page 16) Three patients with severe osteoporosis and roentgenographic evidence of collapse of the vertebra with severe segmental neuralgia and muscle spasm, were unexpectedly relieved for periods up to six months with a single paravertebral injection All evidence indicated that this was not a placebo effect, but probably was due to interruption of the vicious circle of pain—muscle spasm—pain

Post thoracotomy and
Posttraumatic Pain Syndromes

Following injury to the chest or following thoracotomy, some patients develop a dull aching pain

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long as the tip of the needle is within the ligaments there is resistance to the injection By exerting constant unremitting pressure on the plunger of the syringe with the right hand and advancing the needle with the left hand very slowly a lack of resistance is felt as soon as the tip of the needle passes through the ligaments and into the paravertebral region in the immediate vicinity of the nerve as depicted in Figure 29 (B) and (D) Note that the needle is directed in a true sagittal plane

which is accompanied by occasional bouts of severe, lancinating, segmental pain and also by objective evidence of neuropathy in the form of hyperesthesia and hyperalgesia If examination of the scars reveals areas which are unusually sensitive (so-called trigger areas), these are injected, otherwise a paravertebral block is carried out This usually produces relief of pain which may last considerably longer than duration of anesthesia All of these patients should have the benefit of a series of paravertebral blocks because a significant per cent derive lasting benefit from this form of treatment I usually carry out at least six injections before more radical measures, such as rhizotomy or rarely alcohol block is considered

Cancer Pain

Cancer of the thoracic spine with consequent mechanical impingement of one or more of the thoracic spinal nerves, or cancer in the paravertebral region or within the thoracic cavity may produce severe, intractable pain that may necessitate nerve blocks In such instances paravertebral technic is employed if only a few segments are involved If the symptomatology is extensive or bilateral it may be deemed advisable to institute a continuous segmental epidural block If the condition is sufficiently severe and the circumstances warrant it, paravertebral block with alcohol may be carried out and will afford relief of pain for several months

Acute Postoperative Pain

Paravertebral block may be used to control severe postoperative pain following operations of the chest and upper abdomen This procedure has the advantage

old people osteoporosis with collapse of the vertebra and consequent mechanical neuropathy These conditions produce not only pain in the chest but reflex *muscle spasm and segmental hyperesthesia* and *hyperalgesia*

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is usually not severe, and since these blocks are inherent in certain hazards, they should be reserved for the unusual patient that is experiencing sufficiently severe pain which cannot be managed by more conservative measures Postherpetic neuralgia is a complex and most difficult problem which usually cannot be affected by blocks and frequently requires chordotomy But even this fails to relieve all the patients

Intercostal Nerve Block

The simplicity and facility of blocking the intercostal nerves anywhere along their course within the intercostal space makes this procedure one of the most useful technics in nerve blocking There are certain anatomical situations which facilitate blocking and therefore are the preferable sites of injections (Fig 29) Of these, the angle of the rib offers the best situation because it is the most superficial and therefore the most easily palpable and the most accessible part of the rib Injection at this point will block the entire primary division distal to it, but will not involve the posterior division or the sympathetic rami communicantes The next most important site of injection is at the posterior axillary line which will involve the lateral cutaneous branch and its anterior and posterior division and yet spare the intercostal muscle proximal to the line of injection The third site is the anterior axillary line which is adequate in the management of painful conditions involving the distal part of the rib and sternum This procedure, of course, spares the lateral cutaneous branch Lastly, intercostal block in the parasternal area is effected for the management of sternal pain

The use of a 2 to 3 cm , 25 gauge needle obviates the need for a cutaneous wheal After the lower edge

over intercostal block in that it also interrupts the visceral afferent and visceral efferent fibers which may be playing a significant role in the physiopathology On the other hand, since it is difficult to carry out a continuous paravertebral technic, it may be preferable to employ continuous epidural block

Musculoskeletal Disorders

Other disorders of the vertebral column, ribs, sternum, and various chest muscles may be accompanied by severe pain and muscle spasm which may warrant the use of nerve blocks If the process involves the entire nerve and cannot be controlled with local or intercostal block, paravertebral injections may be carried out These procedures should be effected with drugs that produce a prolonged block such as Pontocaine or Nupercaine

Visceral Pain

Since the sensory fibers which supply the viscera, chest and abdomen traverse the formed nerve in the paravertebral region, injection in this area will interrupt these fibers, and therefore could be employed in the management of visceral pain However, in view of the fact that the extradural technic permits the use of an indwelling catheter and thus allows a continuous block, it is preferable to the multiple paravertebral injections which are necessary in order to interrupt the fibers for any one viscus

One of the most effective uses of paravertebral thoracic somatic nerve block is in providing symptomatic relief to patients with severe pain that occasionally accompanies acute herpes zoster It should be stressed, however, that since the pain in this condition

is usually not severe, and since these blocks are inherent in certain hazards, they should be reserved for the unusual patient that is experiencing sufficiently severe pain which cannot be managed by more conservative measures Postherpetic neuralgia is a complex and most difficult problem which usually cannot be affected by blocks and frequently requires chordotomy But even this fails to relieve all the patients

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of the rib is impinged upon, the needle is grasped between the thumb and index finger of the left hand, about 0 5 cm from the skin, and then moved over the lower edge of the rib and advanced until the fingers are flush with the skin (Fig 30) This prevents the needle from being advanced too deep and producing pneumo

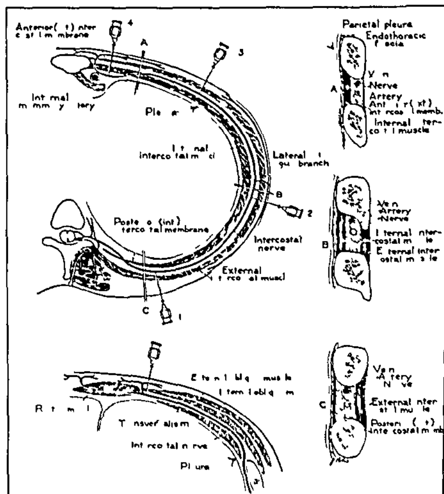


FIGURE 29 Diagrammatic illustration of a typical thoracic spinal nerve The upper diagram shows the relations of a thoracic intercostal nerve to the intercostal muscles and their membranes Note particularly its relationship in the paraver

(Continued on next page.)

thorax which is the only serious complication of this procedure

Intercostal block should be used whenever possible in preference to paravertebral block because there is much less risk in inadvertent injection into the sub arachnoid space or in producing extensive vasomotor paralysis

Postoperative Pain

One of the most important clinical uses of intercostal block is to control severe postoperative pain in the chest or abdomen and in the active treatment of postoperative atelectasis Although the block does not involve the visceral afferent fibers, it does afford almost complete relief of discomfort The advantage it has over continuous epidural or multiple paravertebral block is that it does not involve vasomotor segments and therefore is not followed by hypotension This is especially important in elderly patients with decreased cardiovascular function For this purpose I

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tebral region where it is anterior to the posterior intercostal membrane Also note its position in the parasternal region The lateral cutaneous branch leaves the parent nerve at the mid axillary region and as soon as it reaches the subcutaneous tissue it divides into an anterior and posterior division Needle 1 is in position for posterior intercostal block at the angle of the rib, needle 2 for lateral intercostal block just posterior to the mid axillary region needle 3 for anterior intercostal block at the mid-clavicular line and needle 4 for parasternal intercostal block The left lower diagram shows the relationship of the thoraco-abdominal intercostal nerve in the anterior abdominal wall A B and C show cross section of the intercostal space to depict the relationship of the nerve to the vessels and to the intercostal muscles as well as to the ribs (Bonica *Management of Pain* Courtesy Lea & Febiger)

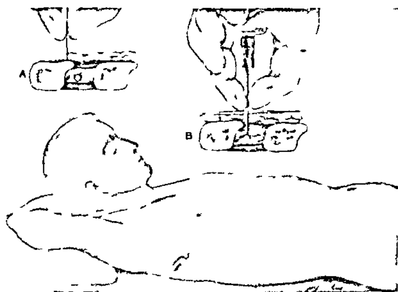


FIGURE 30 Position of the patient for lateral *intercostal block* The injections are done posterior to the midaxillary line in order to include the lateral branch of the intercostal nerve The inserts depict the technic of injection (A) shows placement of the needle with the tip impinged upon the lower portion of the lateral surface of the rib just above its lower edge The needle is grasped between the thumb and index finger on the left hand about 5 mm from the skin then withdrawn and the skin and soft tissues are moved sufficiently caudad with the index finger to allow the needle to slip beyond the lower border of the rib It is then advanced until the fingertips grasping the needle are flush with the skin This is a simple maneuver which minimizes the chance of advancing the needle too deeply and entering the thoracic cavity In the average patient a 1 to 1½ inch 25 gauge needle is employed making it unnecessary to produce a skin wheal The needle is inserted while attached to the syringe and when its point is in the intercostal space 2 to 3 cc of solution is injected after aspiration test is negative

use 0 1% Pontocaine or Nupercaine with epinephrine 1 to 200,000 injecting 3 to 5 cc per segment This provides relief for 5 to 8 hours It is best to carry out the procedure in the early morning so that the patient

is able to effectively cough up secretions which accumulate in the tracheobronchial tree during the night

Posttraumatic Pain

In many patients injuries to the chest produce fractures of the ribs and sternum that cause severe pain which interferes with proper breathing The administration of narcotic analgesics rarely completely relieve the patient and thus do not permit adequate ventilation This, together with the central respiratory depressant effects of these drugs, produces a respiratory insufficiency which may be serious in elderly patients On the other hand, intercostal blocks do provide complete relief of pain without concomitant depression and thus markedly improve breathing In the acute cases the block should be carried out at daily intervals or even more frequently As previously mentioned, dilute solutions of Pontocaine or Nupercaine provide relief for 5 to 8 hours

Occasionally patients who sustain injury to the chest without fracture have residual dull, aching, burning pain which may persist for a long period of time This discomfort is probably due to a periostitis and reflex muscle spasm and can be completely eliminated with intercostal nerve blocks In addition to providing prompt relief of pain, the blocks may shorten the duration of the disability by breaking up the so-called vicious circle

Neuralgia

Intercostal block may be used as a diagnostic, prognostic and therapeutic procedure in the management of intercostal neuralgia Like the paravertebral technic this method is most effective in the treatment of

posttraumatic, postinfectious, and postoperative neu ralgia The same comments in connection with para vertebral block apply here If this technic is completely effective, it is preferable to paravertebral block for reasons previously mentioned

Cancer Pain

Intercostal block may be used in the management of cancer pain The injection of alcohol in the intercostal space is simpler to carry out than paravertebral injec tions and is followed by a higher percentage of suc cesses For this purpose, 35 to 50% alcohol is sufficient to produce sensory blockade This concentra tion can be obtained by mixing the alcohol with Xylo caine or one of the other local anesthetic drugs which provide some immediate analgesia and thus makes the injection much less painful It should be stressed that the injection of alcohol into the intercostal space without prior injection of local anesthetic is a very painful experience for the patient Therefore, it is ad visable to either inject the local drug prior to alcohol or to give the patient some narcotic analgesic and/or thiopental intravenously or even administer an inhala tion anesthetic to obviate the psychic and physical discomfort associated with the alcohol injection

Differential Diagnosis

Intercostal nerve block may be used to advantage in helping to make differential diagnosis of pain in the chest By carefully carrying out the procedure, at a distance from the paravertebral region and using small volumes (3 ml) one is able to interrupt the nerves to the somatic structures of the chest wall without affect-

ing the visceral nerve supply Complete relief following such procedure is presumptive evidence that the primary cause of the disease is in the chest wall Of course, the interpretation of the results require a serious consideration of the mechanism of referred pain because as previously mentioned, in some instances, removing the somatic components of visceral disorders may provide considerable relief (page 116) This may lead the unwary, inexperienced physician to be misled On the other hand, if the information obtained from the block is considered with all of the other data available from the history and physical examination, this method may be useful in helping to make the diagnosis

C BLOCK OF THE LUMBAR AND SACRAL SPINAL NERVES

The lumbar and sacral nerves here are considered together because they have a common function — nerve supply of the pelvis and lower extremity — and consequently are frequently involved together in conditions which indicate nerve blocks Since these nerves, like those to the upper extremity, contain somatic sensory, somatic motor, and sympathetic fibers, block of these structures may be employed in the management of the same disorders discussed for the upper extremity

Paravertebral Block

Paravertebral block in the lumbar and sacral region is considerably easier than block in the thoracic region, and is followed by fewer and much less serious complications * Because of their large size, it is almost

*The technic in placing the needle is the same as in the thoracic region (p 211)

difficult to miss the lumbar nerves in paravertebral injection Paravertebral injection of the sacral nerves is carried out by inserting the needle through the posterior sacral foramina and advancing it until its point is just lateral to the sacral canal — the so-called transsacral block

Lumbar paravertebral block is indicated in the management of painful conditions of the lumbar vertebra, the kidney and inguinal regions, and the anterior part of the thigh I have employed it to advantage in controlling severe pain of fractured vertebra, painful post herniorrhaphy scars, meralgia paraesthetica, and segmental neuralgia Sacral block may be employed to control severe pain in the lower extremity produced by musculoskeletal disorders which involve one or two segments Paravertebral block in this region is particularly useful as a diagnostic-prognostic measure to ascertain the mechanism of the pain and to predict the effects of a contemplated neurosurgical operation

In young people neuralgia is usually due to herniated intervertebral disc, whereas in older individuals it is most frequently due to arthritis or osteoporosis or other chronic mechanical disorders Again I am prompted to remind the reader that in order to obtain optimal results with this method, it is essential to try and determine the cause Nerve blocks should be reserved only for those patients who are experiencing severe pain Paravertebral block is more of a diagnostic-prognostic value than as a therapeutic measure In the event the severe pain persists it is better to institute a continuous epidural block to provide uninterrupted relief for several days For reasons previously given, alcohol should not be employed except

in patients with severe, intractable pain due to inoperable cancer

Sciatic Nerve Block

Since the sciatic nerve contains the majority of the sensory and sympathetic fibers for the lower extremity, sciatic nerve block may be used to temporarily control severe, acute pain of the lower extremity, and also to produce complete sympathetic interruption of the foot and leg The simplicity and facility of blocking this nerve make it a valuable diagnostic prognostic procedure to corroborate the effects of lumbar sympathetic block, to aid in the differential diagnosis of the origin of the pain, and occasionally it may be indicated as a therapeutic measure in patients with severe vasospasm and pain of the lower extremity It should be stressed that since it contains nerves to the muscles of the extremity, its interruption is followed by weakness or paralysis This disadvantage limits its usefulness as a therapeutic measure to those patients who have very severe pain and vasospasm that cannot be managed in any other way *The injection of alcohol in or about the sciatic nerve is absolutely contraindicated except in patients with inoperable cancer who are in the terminal stage of the disease and paralysis of the extremity is of no consequence*

For diagnostic prognostic purposes, it is suggested that a short acting drug such as Nesacaine or procaine be employed On the other hand, if there is reason to provide prolonged interruption Pontocaine or Nupercaine should be used in dilute concentration In addition to the paralysis of the extremity, the complications which may occur following this block include

difficult to miss the lumbar nerves in paravertebral injection Paravertebral injection of the sacral nerves is carried out by inserting the needle through the posterior sacral foramina and advancing it until its point is just lateral to the sacral canal — the so-called transsacral block

Lumbar paravertebral block is indicated in the management of painful conditions of the lumbar vertebra, the kidney and inguinal regions, and the anterior part of the thigh I have employed it to advantage in controlling severe pain of fractured vertebra, painful postherniorrhaphy scars, meralgia paraesthetica, and segmental neuralgia Sacral block may be employed to control severe pain in the lower extremity produced by musculoskeletal disorders which involve one or two segments Paravertebral block in this region is particularly useful as a diagnostic-prognostic measure to ascertain the mechanism of the pain and to predict the effects of a contemplated neurosurgical operation

In young people neuralgia is usually due to herniated intervertebral disc, whereas in older individuals it is most frequently due to arthritis or osteoporosis or other chronic mechanical disorders Again I am prompted to remind the reader that in order to obtain optimal results with this method, it is essential to try and determine the cause Nerve blocks should be reserved only for those patients who are experiencing severe pain Paravertebral block is more of a diagnostic prognostic value than as a therapeutic measure In the event the severe pain persists, it is better to institute a continuous epidural block to provide uninterrupted relief for several days For reasons previously given, alcohol should not be employed except

toxic reactions which are rare and postinjection neuropathy which occurs as a result of improper technic

Femoral and Lateral Cutaneous Nerve Block

Block of the femoral nerve is rarely used as a therapeutic measure It may be used as a diagnostic procedure in the management of neuralgia and other severe pain, and as a concomitant to sciatic nerve block in order to effect sympathetic interruption of the lower extremity This procedure is simple to carry out

Block of the lateral cutaneous nerves is indicated in the unusual circumstances in which there is severe pain in the anterolateral surface of the thigh and in the management of meralgia paraesthetica The latter condition is a relatively common disorder due to various etiologic factors, most of which can be eliminated (116) However, there is a group of patients in whom the cause cannot be found and the diagnosis of "idiopathic" meralgia paraesthetica is made The treatment of this condition is usually conservative Only in patients who are experiencing severe pain should nerve blocks be considered In such instances repeated blocks may effect long lasting benefit

Obturator Nerve Block

Obturator nerve block may be used in the management of adductor muscle spasm and painful hips Since this nerve contributes the major portion of the nerve supply to the hip joint, it can be employed to predict the affects of obturator neurectomy in patients with severe intractable pain in the hips due to osteo arthritis or malignancy It should be stressed however,

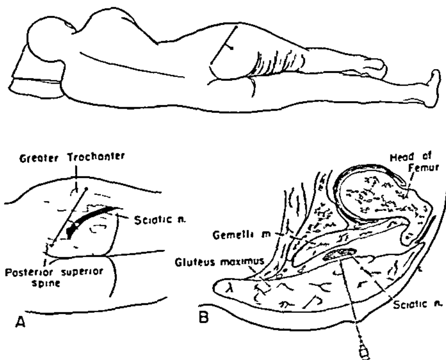


FIGURE 31 *Technic of sciatic nerve block* The top figure shows the patient in Sim s position and the landmarks marked on the skin (A) Shows relation of the nerves to the bones and method of locating the nerve The line extending from the upper portion of the greater trochanter to the posterior superior iliac spine is bisected and a perpendicular line is drawn from the point of bisection in an inferior and medial direction for a distance of 3 cm. This is the site of puncture After the formation of a skin wheal a 10 cm 22 gauge needle is introduced in a direction perpendicular to the skin and advanced until paresthesia is obtained or bone is contacted. If paresthesia is not obtained the needle is withdrawn until its point is directed cephalad or caudad along the bisector After several such fanwise insertions the nerve is easily located (B) Is a cross section at the level of the block.

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that the hip receives a significant contribution by the posterior articular branch (derived from the nerve to the quadratus femoris or directly from sciatic nerve) and an anterior articular branch (derived from the nerve to the rectus femoris, a branch of the femoral nerve) Therefore, in most instances, in order to obtain complete relief of pain of the hip joint, it is necessary to block the nerve to the quadratus femoris and the femoral nerve Other than for diagnostic-prognostic purposes this procedure is too drastic a measure and cannot be considered for therapeutic purposes, except in the management of mass reflex spasm of the ad ductor muscles Some writers have reported benefit from a series of bilateral blocks in patients with this condition consequent to spinal cord injury (117) In such patients alcohol block may be considered

Complications which may occur following this procedure are lacerations of the obturator vessels with consequent hematoma and inadvertent intrapelvic injection with possible perforation of viscus and consequent infection These can be avoided with proper technic and the use of roentgenograms in placing the needles

Saphenous Nerve Block

Block of the saphenous nerve at the level of the knee as it emerges between the gracilis and sartorius muscles and becomes subcutaneous may be used in controlling severe acute or chronic pain in the anterior or medial aspect of the leg due to trauma, ischemic neuritis or ulcer Since it is a pure sensory nerve one can use a neurolytic agent such as alcohol to effect prolonged block without any undesirable effect other than mild postinjection neuritis Several prognostic

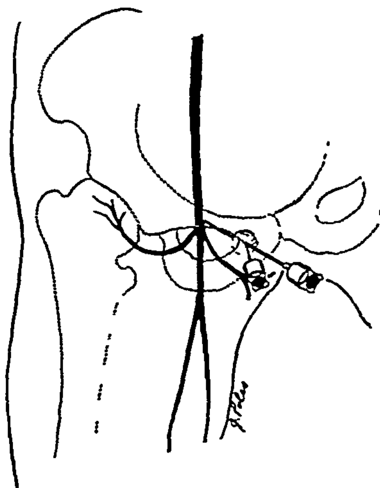


FIGURE 32. *Technic of obturator nerve block* A 22 gauge 8 cm. needle is introduced through a wheal formed 1 cm. lateral and inferior to the public tubercle and slowly advanced until the upper part of the inferior ramus of the pubis is contacted The direction of the needle is then changed directing its point in a lateral and slightly superior and posterior directions so that the shaft is parallel with the inferior border of the superior ramus of the pubis. The needle is then slowly advanced while its point is kept in constant contact with the inferomedial surface of the superior ramus of the pubis Approximately 2 cm beyond the point when contact with the bone is lost 10 ml of solution is injected.

blocks should always be done prior to saphenous neurotomy if such a procedure is contemplated for the management of severe painful conditions The technic is simple and effective and can be completed with 3 to 5 ml of local anesthetic solution

Ilioinguinal and Iliohypogastric Nerve Block

Block of the ilioinguinal and/or iliohypogastric nerve may be indicated in the management of neuralgia or other severe pain which may accompany herpes zoster, injuries and surgical scars The block may be accomplished in the paravertebral region or in the region of the superior iliac spine In the latter technic the lack of deep bony landmarks and the small size of the nerves make it difficult to elicit paresthesia and to permit a specific block Consequently, one needs to rely on the use of fairly large volumes (5 to 10 ml or more) in order to block these nerves For obvious reasons, alcohol or other neurolytic agents should never be used for this procedure

Block of the Tibial and/or Peroneal Nerves

(At the Levels of the Knee or Ankle)

Block of the tibial and/or peroneal nerves either at the level of the knee or ankle may be used for the same indications mentioned in connection with block of the nerves to the upper extremity at the elbow or wrist Rarely patients develop severe pain following injury or operation which cannot be relieved with narcotics and requires a temporary somatic nerve block They may also be used to produce sympathetic block of the foot for diagnosis or therapy Since these

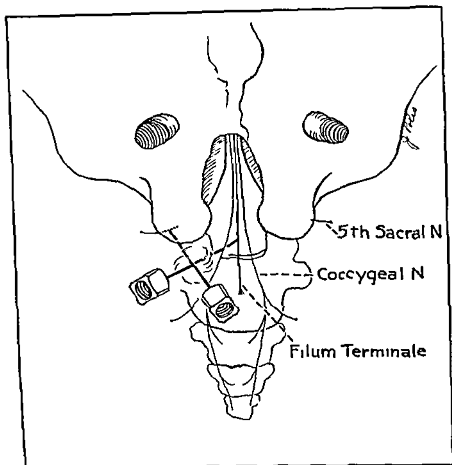


FIGURE 33 Course and *technic of injecting the 5th sacral and coccygeal nerves* This procedure is carried out in the treatment of coccygodynia

nerves carry the fibers to the muscles of the leg and foot, a prolonged block cannot be considered except in very unusual circumstances Block of the peroneal and tibial nerves is also employed to determine the amount of vasospasm in peripheral vascular disease and thus confirm the results of lumbar sympathetic block These technics may be preferred to sciatic

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femoral nerve block because they are simpler to carry out and the undesirable effects are less

Block of the lateral and dorsal cutaneous nerves (branches of the superficial peroneal nerve), medial calcaneal, and other less important cutaneous nerves of the foot may be indicated as diagnostic and therapeutic procedures in controlling severe pain or intractable itching in the foot Occasionally it is necessary to also inject the deep peroneal and the tibial nerves at the ankle in order to provide complete relief of pain in the foot Crush of cutaneous nerves of the foot may be considered to control severe pain due to ischemic neuritis and/or ulcerations of the foot in patients with diabetes and obliterative diseases In such instances a prognostic block with a local anesthetic block is indicated

TABLE IV
Summary of Technics of Spinal Nerve Blocks

Technic	*Usual Site of Injection*	*Approximate Volume of Solution (in ml or cc)*
A Head and Neck		
1) Paravertebral	Paravertebral space	3 4 per nerve
2) Deep plexus	Paravertebral space C2 C3 C4	3 4 per nerve
3) Occipital	Superior nuchal line	2 3
4) Superficial plexus	Subcutaneous in midportion of posterior border of sternomastoid muscle	10 15
B Upper Extremity		
1) Paravertebral	Paravertebral region C5 C6 C7 C8 T1	3 5 per nerve
2) *Brachial plexus*	*Supraclavicular region* just above midpoint of clavicle	20 30
3) Median	At the arm elbow or wrist	5 10
4) Ulnar	At the arm elbow or wrist	5 10
5) Radial	At the arm elbow or wrist	5 10
6) Suprascapular	Suprascapular notch	5 10
C Lower Extremity		
1) Paravertebral	Paravertebral region L2 S3	5 7 per nerve
2) Sciatic	Greater sciatic foramen or posterior aspect of thigh	15 25
3) Femoral	Femoral triangle	5 10
4) Lateral Femoral Cutaneous	Near anterior superior iliac spine	5 10
5) Obturator	Obturator canal	10 15
6) Popliteal	Popliteal fossa	10 15
7) Peroneal	Lateral aspect of neck of fibula	5 10
8) *Anterior and* Posterior Tibial	At the ankle	10 20
D Trunk		
1) Paravertebral	In paravertebral space just lateral to intervertebral foramen anywhere along spine	5 per nerve
2) Intercostal	Intercostal space at the angle of the rib mid axillary line midclavicular line or parasternal region	3 5 in each intercostal space

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CHAPTER XI

EXTRADURAL BLOCK

(Caudal and Segmental Spinal Epidural Block)

Injection of local anesthetic solutions and other agents into the extradural space is one of the most effective means of producing interruption of sensory, and motor as well as autonomic components of spinal nerves Since the space extends from the sacrococcygeal hiatus caudad to the foramen magnum cephalad, this method may be employed for the management of disorders involving the body below the neck region The fact that a catheter inserted into the peridural space can be maintained without displacement for hours, and even days, much more easily and with less risk than a catheter placed in the subarachnoid space, paravertebral region, or any other part of the body, makes this method superior to almost any other and makes it more useful and applicable in a greater variety of conditions (118) By carrying out a precise segmental block restricted to the neurotomes involved in the disorder and by employing appropriate concentrations of local anesthetics one is able to produce a differential sensory and vasomotor block without significantly involving the skeletal muscles Such effects provide optimal diagnostic and/or therapeutic conditions with obvious advantages to the patient

The extradural technic offers many advantages over other regional procedures as a diagnostic, prognostic, and therapeutic method The fact that with peridural block the subarachnoid space is not invaded is a consistent advantage over subarachnoid block since it obviates the problem of headache and the potential (though extremely rare) hazards of meningeal irritation, arachnoiditis, and toxic effect on the spinal cord Moreover, since the dural attachment to the entire circumference of the foramen magnum forms an impenetrable barrier to any fluid proceeding cephalad, there is considerably less chance of producing cerebral effects with extradural block than with spinal anesthesia Moreover, it is easier to produce a limited segmental spinal epidural block and in many instances it is not necessary to involve the lower lumbar and sacral segments, so that the visceromotor fibers to the bladder, rectum, and other pelvic viscera and the somatomotor fibers to the muscles of the lower extremities can be spared This obviates dysfunction of the bladder and rectum and permits the patient to ambulate and thus perhaps decreases the risk of thrombo-embolism inherent in spinal anesthesia or any other method which produces inactivity of the lower extremities

Since peridural anesthesia requires only one puncture, it has significant advantage over multiple paravertebral or intercostal block The usefulness and applicability of extradural block is greatly enhanced by the continuous technic which makes possible extension of the duration of a block

CLINICAL APPLICATION

I am firmly convinced that extradural block* has

*(Footnote will be found at bottom of page 234)

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ology of various disorders and not infrequently aid and perpetuate the so-called vicious circle

It bears reemphasis that in order to realize optimal results with this technic, it is necessary to consider the patient carefully and apply all of the basic principles discussed in Chapter IV This is particularly important with peridural blocks because of their wide flexibility of application, diversibility of effect and the serious (though rare) potential hazards inherent in their use

Postoperative Pain

Segmental peridural block is especially useful in managing severe, postoperative pain which is occasionally seen after any operation, but particularly after those in the chest and the upper abdomen By properly placing a catheter and by using small volumes of dilute solutions of local anesthetic drugs, a complete sensory and sympathetic blockade may be effected without interfering with the function of the skeletal muscles Since the sensory block involves somatic and visceral fibers, it not only provides relief of pain but prevents the development of abnormal reflex responses consequent to surgical trauma and postoperative irritation arising from the field of operation These abnormal reflex disturbances lead to skeletal muscle spasm, bronchiolar spasm, inhibition of gastrointestinal func tion, and reflex renal, splanchnic and other visceral arteriolar spasm, which in turn lead to such postoperative complications as hypoventilation (and con sequent atelectasis, pneumonitis), ileus and abdominal distention, and oliguria

In dealing with this problem, it is obvious that proper application of segmental peridural block is a

its greatest usefulness as a diagnostic, prognostic, and therapeutic measure in the management of various disorders (118) While improvements and advances in general anesthesia have caused regional technics, including peridural block, to be used less and less for surgical anesthesia, the use of these technics for medical problems has been increasing Results in our clinic have caused us to agree heartily with Ciocatto (119) and others (120, 121, 122), who claim that the potentialities of extradural block for this purpose have not been fully explored

It may be employed advantageously as a diagnostic method in problem cases in order to provide information concerning the mechanism of pain or other disturbances and to corroborate data obtained with other block technics and other diagnostic aids It is very useful as a prognostic procedure to help predict the probable effects of prolonged nerve interruption This procedure may provide important information to the neurosurgeon if surgical section of the pathway is contemplated and will afford the patient an opportunity to experience numbness, paresthesia, weakness, and other effects resulting from the operation Its value as a therapeutic measure results from the fact that it produces a concomitant interruption of pain pathways and abnormal reflex autonomic and skeletal muscle responses which frequently take part in the physiopath

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*In the following discussion on the clinical application of this method extradural peridural and epidural are considered synonymous and will be used interchangeably As will be mentioned in the next section of this chapter the effects are the same whether the injection is made via the sacrococcygeal hiatus (caudal) or at the spinal levels — only the segments involved vary caudal block is usually reserved to block the lower lumbar and sacral neurotomes whereas the spinal route is used to produce segmental block of lumbar thoracic and cervical segments

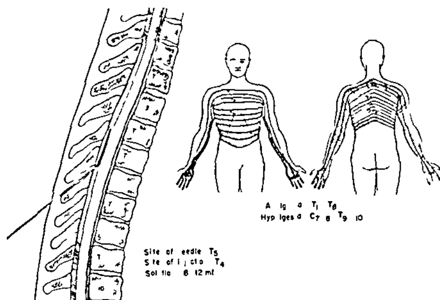


FIGURE 34 Pattern of analgesia and hypalgesia produced by *continuous epidural block* to control post thoracotomy pain The needle is inserted in the 5th thoracic interspace and the catheter advanced so that its tip is at the level of the 4th thoracic vertebra

sacral nerves It is particularly useful in managing cases of herpes zoster, and other post-infectious, post-toxic, or neoplastic neuropathies accompanied by severe discomfort In patients with severe segmental or peripheral nerve pain due to osteoarthritis, root-sleeve fibrosis, or other skeletal disorders, continuous peridural block has proven of great benefit by providing temporary relief, obviating the associated skeletal muscle spasm and sympathetic dysfunction, and permitting the use of traction and other physical therapeutic measures which otherwise could not be employed

Some clinicians have employed peridural block as a therapeutic measure in patients with sciatic neuritis

method superior to the commonly employed narcotic analgesics which do nothing to prevent or correct these physiopathologic processes but rather aggravate them Bromage (123) and Cleland (124) have demonstrated the superiority of this method with spirometric studies In our clinic peridural block has been used for this purpose with excellent results I prefer 0 1% Pontocaine or Nupercaine because these drugs provide analgesia for four to six hours and occasionally longer without significantly affecting the intercostal muscles For optimal results the block should be limited to the segments involved and to concentrations which produce sensory (pain) block without concomitant muscle paresis For post-thoracotomy pain the catheter is placed in such a way that its point is in the segment of the removed rib (Fig 34) For upper abdominal surgery its point is placed at the 8th thoracic segment (Fig 36), for lower abdominal surgery at the 11th thoracic, and for lower extremity surgery at the 5th lumbar

In a number of patients we have employed this method as a prophylactic postoperative measure to prevent vasospasm, dysfunction, edema, and other signs of reflex dystrophy that sometimes follow surgery of the extremities It has also been used to treat these symptoms after they have developed The favorable results noted in both groups have prompted everyone concerned to consider this method as an indispensable tool in the management of these patients

Neuritis and Neuralgia

Segmental peridural block may be used to control severe pain associated with segmental or peripheral neuralgia involving the cervical, thoracic, lumbar, or

that of the upper extremity at the level of the 7th cervical vertebra

Peripheral Vascular Disease

One of the most important clinical applications of peridural block is in the management of peripheral vascular disorders, particularly in those cases in which vasospasm is predominant In such instances this method not only effects sympathetic interruption, which alleviates reflex vasospasm of collateral vessels, dilates fully those vessels that can be dilated, and aids the absorption of edema, but also provides relief of ischemic (somatic) pain When only sympathetic block is desired the catheter is placed with its tip at the

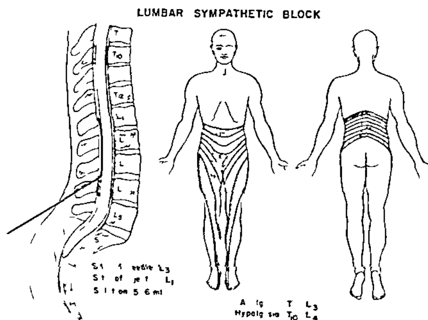


FIGURE 35 Pattern of analgesia and hypalgesia developing with continuous *epidural block* carried out to produce lumbar sympathetic interruption

claiming that it effected a cure in a significant percentage of patients (125, 126, 127) Some of these authors explain the results on the basis that acute sciatic neuritis is frequently due to infection and is accompanied by reflex muscle spasm While it is true that nerve block, in addition to immediate relief of severe pain, may provide prolonged beneficial effects by relieving muscle spasm and interrupting the so called vicious circle, it should be remembered that the most frequent cause of "sciatica" or lumbosacral neuralgia is herniation of an intervertebral disc It is essential not to misuse this or any other nerve block technic in such cases, lest everyone concerned may be misled into improper treatment of the condition In patients with surgically treatable lesions that produce neuropathy and neuralgia, blocks should be employed only as a temporary measure to provide symptomatic relief

Causalgia and Other Reflex Dystrophies

Continuous segmental peridural block is one of the best, if not the best, method of effecting sympathetic interruption and providing relief in patients with causalgia and other reflex dystrophy of the upper or lower extremity (49, 118, 128) The advantage it has over pure sympathetic block is that it promptly relieves somatogenic pain In cases of post-amputation pain peridural block may be used as a diagnostic and prognostic aid to predict the effect of neurosurgical operation Occasionally some of these patients receive prolonged benefit from a block extended for days

For concomitant sympathetic and somatosensory block of the lower extremity the catheter is placed with its tip at the level of the 5th lumbar vertebra and for

Musculoskeletal Disorders

Severe, intractable pain owing to fractured ribs, fractured vertebrae, and osteoarthritis of the spine or hips, periarthritis, bursitis, tendinitis, and severe muscle spasm may be relieved very effectively with continuous peridural or caudal block I have found this method especially useful in patients with multiple fractures of the ribs, clavicles, and bones of the extremities who could not be relieved with large doses of narcotics, which not only failed to provide relief, but also markedly depressed the respiration and endangered the patient with the potential hazard of pulmonary complications

It should be stressed that this technic should be reserved for those patients who cannot be managed by more conservative measures Despite the aforementioned advantages of peridural block, one should always keep in mind the possible hazards and complications, especially hypotension which is likely to occur whenever an extensive block is necessary Localized lesions may be better managed with intercostal block The only advantages the extradural technic offers over intercostal and paravertebral block are that it requires only one puncture and permits the use of a continuous catheter and thus makes possible uninterrupted relief of pain It bears reemphasis that each patient and his problem should be considered individually

Visceral Pain

Many clinicians (12, 110, 119, 121, 122, 129, 130) have reported excellent results with this method for the treatment of acute pancreatitis In addition to providing relief of pain, the sympathetic block is also said

level of the 1st or 2nd lumbar vertebra for the lower extremity and at that of the 1st thoracic vertebra for the upper extremity

In my experience this method has been of therapeutic value in patients with traumatic segmentary vasospasm, acute arterial occlusion as a result of embolism or thrombosis, arterial aneurysm, and circulatory insufficiency secondary to frostbite, trench foot and immersion foot The facility with which a continuous block can be maintained makes this technic especially useful in managing patients with peripheral vascular disease for whom a trial of conservative management is indicated but who eventually require surgery In such cases the continuous technic is used for preoperative relief and trial on sympathetic block and then continued to provide surgical anesthesia for embolectomy or other operations and to effect postoperative analgesia and sympathetic block This method is also useful in patients with acute thrombophlebitis who have severe pain and edema

In patients with Raynaud's disease and other chronic vasospastic disorders peridural block is only of value to provide temporary relief or as a prognostic measure It can be used to confirm the results obtained with paravertebral sympathetic block The same applies to the use of this method in patients with thromboangiitis obliterans and arteriosclerosis obliterans In patients with severe pain, ulcerations, and other trophic changes, continuous peridural block extended over a period of several days may prove of benefit in providing both relief of severe ischemic pain and sympathetic interruption which may halt the process until sympathectomy can be done

and ureteral colic In a significant number of these patients the block not only relieved severe pain but relaxed the ureter sufficiently to permit advance of the calculus to a point where it could be removed through a cystoscope, thus obviating an open operation The tip of the plastic tubing should be at the level of the 12th thoracic vertebra

This method has been used to control severe, intractable pain consequent to ruptured peptic ulcer, acute cholecystitis, and other acute abdominal disorders In such instances the block is initiated early to provide temporary relief during the preoperative period and then extended for the operation Evidence has been adduced which suggests that continuous sympathetic interruption effects subsidence or arrest of the inflammatory process of acute cholecystitis (111) Of the many technics that can be used for this purpose continuous peridural block is the most practical

Its use has also been suggested as a diagnostic-therapeutic measure for various other abdominal visceral disorders, including congenital megacolon, spasm of the cardia, pylorus, and other sphincters, biliary dyskinesia, postcholecystectomy syndrome, celiac ganglion syndrome, gastrointestinal pain of undetermined origin, chronic pancreatitis, visceral crises of tabes dorsalis, idiopathic nephralgia, intractable bladder pain, orchitis, salpingitis, and dysmenorrhea (12, 119, 122, 127, 131) While it is true that peridural block produces complete sensory and sympathetic interruption and may thus improve temporarily the physiologic abnormalities and provide relief of pain if this symptom is present further studies need to be done to clarify the value of this method for these purposes

One of the most important and fruitful uses of seg-

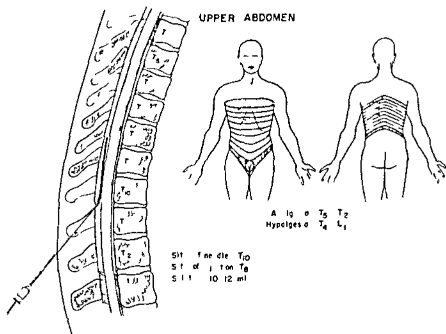


FIGURE 36 Pattern of analgesia and hypalgesia produced by means of continuous *epidural block* to control pain in the upper abdomen as occurs with acute pancreatitis

to relieve reflex spasm of the visceral vessels, the duodenum, the sphincter of Oddi, and the entire ductal system of the pancreas, so that there is rapid release of the extra-ductal pressure with the emptying of the ductal system of its toxic fluids The block also inhibits reflex ileus which frequently complicates acute pancreatitis Although this technic has proven to be the best method of providing pain relief, I am not convinced that continuous peridural block significantly improves the physiopathologic process For the treatment of pancreatitis the catheter is placed with its tip at the level of the 8th thoracic vertebra

I have noted good results after using segmental spinal peridural block for the management of renal

of the blood "wedge" splitting the coats of the aorta and may thus inhibit progression of the disease. Moreover, the block obviates reflex renal vasoconstriction and subsequent anuria which often accompany dissection of abdominal aneurysm. It should be stressed that since this procedure produces hypotension it must be used with great caution in patients who have coronary sclerosis or other cardiac pathology.

Many reports have been published during the past 35 years on the use of sympathetic block in the management of reflex anuria (12, 119, 121, 132, 133). Although the results noted in our clinic have been variable, I believe that if anuria is on a reflex basis it is worthwhile to institute continuous segmental peridural block to attempt to initiate diuresis. The interruption should be limited to the involved segments and should be continued for several days.

Many writers (120, 121, 125, 132, 134, 135) have reported dramatic beneficial effects from continuous extradural block in patients with eclampsia and other forms of toxemia of pregnancy. The block should be extended until it produces sufficient lowering of the blood pressure and should be continued until after the delivery. Most of our patients experienced rapid relief of headache and showed an increase in urinary output.

I consider segmental peridural block an effective procedure for sympathetic interruption as either a prognostic or therapeutic measure in patients with hypertension. For this purpose this method may be preferred to subarachnoid block since it does not involve the lower extremities. It is also preferred to paravertebral block because it produces more complete and more certain sympathetic interruption. It may be extended to provide surgical anesthesia.

mental spinal extradural block is for the treatment of severe ileus As mentioned on page 185, in each of three patients with intractable, gravely severe abdominal distention due to adynamic ileus, spinal epidural block effected dramatic reduction of the ileus and undoubtedly saved the patient's life

The use of peridural block has also been suggested for the treatment of pleuritis, pulmonary embolism and pulmonary edema, bronchial asthma, pulmonary fibrosis, and emphysema (120, 121) Bromage suggests that the beneficial effects are due to bronchial dilatation brought about reflexly by hypotension and by reduction of pressure in abnormal anastamotic channels I have not had experience in the use of this method for these pulmonary disorders, except pleuritis, and therefore cannot render an opinion

Cardiovascular Disorders

Ciocatto (119) and others (120) have suggested the use of limited segmental block in the treatment of intractable cardiac pain Electrocardiographic studies made by Groenendijk (120) demonstrated that in young patients with normal heart, high thoracic peridural block produced no changes in the electrocardiogram whereas in older patients with angina pectoris improvement was noted, particularly in the form of a decrease in the depression of the ST segment He reported similar effects following stellate ganglion block

This technic may be used to provide sustained relief in patients with severe intractable pain owing to dissecting aneurysm of the aorta Bromage (121) believes that the vascular hypotension consequent to the block not only relieves pain but reduces the force

best carried out with a 20 gauge spinal needle, the point of which is passed approximately 2 cm beyond the sacrococcygeal ligament For the continuous technic a special 18-gauge, thin-walled needle which allows passage of 1mm bore vinyl plastic tubing is used The tubing is marked at 5 cm intervals The marked tubing is advanced to a variable distance depending on which nerves are to be blocked, for sacral block the tubing is introduced about 8 cm beyond the hub of the needle, and for block of the lumbar segment 15 cm In this way the tip of the plastic tubing is placed in close proximity to the segments to be blocked, approximately at the level of the 3rd sacral and 5th lumbar, respectively This permits the use of smaller volumes and more specific block than is possible with the standard caudal technic in which the solution is injected into the lower level of the sacral canal because with the latter technic the solution must fill the lower portion of the latter before proceeding cephalad Usually 10 ml of solution injected at the level of the 3rd sacral vertebra produces analgesia of the sacral and lower lumbar segments, 15 ml injected at the 5th lumbar vertebra level involves all the segments below the 1st lumbar The concentration of the solution is similar to that in spinal epidural block

For block of the lumbar, thoracic and cervical segments spinal peridural injection is preferred to the caudal route, because it permits a segmental block which spares the sacral neurotomes carrying the visceromotor fibers to the bladder and rectum and somatomotor fibers to muscles of lower extremity Despite these and other advantages, the position of spinal epidural block in common anesthesiologic practice is far too uncertain for a technic first described in 1921

Some writers (119, 121, 122) have reported the use of extensive sympathetic blockade effected by the peridural method in the treatment of hypertensive cardiac failure Although theoretically the bloodless phlebotomy that accompanies widespread vasomotor paralysis should relieve both the back pressure on the pulmonary vascular bed and the strain on the left side of the heart, our results have been poor in the small number of patients in whom this and other blocks have been tried for this purpose

Severe, intractable headache which follows lumbar puncture has been treated successfully by injecting saline into the extradural space (136) The sacrococcygeal approach is usually employed but the same effects may be obtained by injecting solution into the lumbar peridural space Usually 30 to 60 ml of normal saline are needed to produce the desired effects

Cancer Pain

Segmental analgesia provided with continuous peridural block is of great value as a diagnostic, prognostic, and therapeutic measure in patients with severe, intractable pain associated with cancer (*12*, *49*, *118*, 137) This method is particularly useful in providing relief from pain of the trunk and lower extremities for days or weeks, and it also helps predict the effects of alcohol injections or chordotomy

COMMENTS CONCERNING, TECHNICS, AGENTS, AND EFFECTS

The technic of single injection and continuous caudal analgesia are too well known to warrant a detailed discussion The single injection technic is

best carried out with a 20-gauge spinal needle, the point of which is passed approximately 2 cm beyond the sacrococcygeal ligament For the continuous technic a special 18-gauge, thin-walled needle which allows passage of 1mm bore vinyl plastic tubing is used The tubing is marked at 5 cm intervals The marked tubing is advanced to a variable distance depending on which nerves are to be blocked, for sacral block the tubing is introduced about 8 cm beyond the hub of the needle and for block of the lumbar segment 15 cm In this way the tip of the plastic tubing is placed in close proximity to the segments to be blocked approximately at the level of the 3rd sacral and 5th lumbar, respectively This permits the use of smaller volumes and more specific block than is possible with the standard caudal technic in which the solution is injected into the lower level of the sacral canal because with the latter technic the solution must fill the lower portion of the latter before proceeding cephalad Usually 10 ml of solution injected at the level of the 3rd sacral vertebra produces analgesia of the sacral and lower lumbar segments 15 ml injected at the 5th lumbar vertebra level involves all the segments below the 1st lumbar The concentration of the solution is similar to that in spinal epidural block

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This is probably due to certain misconceptions which exist and which warrant a few remarks here A more detailed discussion of this subject is found else where (118)

One might begin by stating that this technic is a more difficult procedure to master than subarachnoid and caudal block Consequently until the physician becomes skilled in its execution, he will encounter a relatively high rate of failures It should be stressed, however, that with proper preparation successful blocks can be carried out in over 90% of the instances

Usually the procedure is accomplished with the pa tient in lateral position, lying on the side which requires the most intense anesthesia For diagnostic, prognostic, and therapeutic blocks it is best to select the site of puncture which will permit the injection to be made in the center of contemplated band of anal gesia Thus if the block is to involve the 5th to the 10th thoracic neurotome, it is advisable that the site of injection be at T_7 or T_8 It is essential that the physician obtain considerable experience and skill in performing the block in the lumbar area, where the epidural space is largest, where it is hence easier to perform the puncture, and where there is no danger of damaging the spinal cord, before he attempts it above the 1st lumbar vertebra

For reasons given elsewhere (118, 138), the paramedian approach is employed except for single in jection in the upper thoracic, lower cervical, and lum bar regions The paramedian approach permits the needle to be inserted at such an angle as to facilitate advance of the catheter, as shown in Figure 38

The best method is ascertaining the proper place ment of the point of the needle into the peridural space

is the loss of resistance test (Fig. [illegible]) when the procedure is done below the midthoracic level, and the hanging drop test or Macintosh balloon when it is done above the site.

When the continuous technic is employed, it is inadvisable to advance the plastic tubing more than 3 cm. lest the peridural vessels be traumatized. Such trauma-



Figure [illegible]. Sagittal section in the region of the lumbar portion of the spine, showing the correct technic of locating the peridural space by the "lack-of-resistance" test in carrying out peridural block. A. Some resistance is offered by the interspinous ligament to the injection of the saline. B. The point of the needle is in the ligamentum flavum, which offers great resistance. C. Entrance of the point of the needle into the peridural space indicated by sudden lack of resistance to the injection of saline. The force of the injected solution pushes the dura-arachnoid away from the point of the needle. (Bonica. Courtesy Anesthesiology.)

tion enhances the possibility of hemorrhage and rapid absorption, with consequent increase in the incidence of general toxic reactions and failure of the block

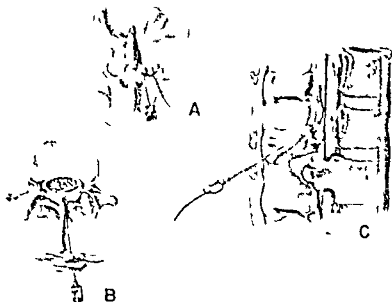


FIGURE 38 *Technic of continuous peridural block in the lumbar region* by the paramedian route (A) Posterior view and (B) superior view showing the relationship of the site of the puncture direction of the needle and the spinous processes Note that the wheal is made 1 5 cm from the midline at the level of the lower tip of the spinous process The special 18 gauge T (thin wall) peridural needle is introduced so that its axis makes an angle of approximately 15 degrees within the midsagittal plane and 135 degrees with the long axis of the spinal canal The needle is advanced through the ligamentum flavum in the same fashion as depicted in Figure 39 (C) Sagittal view to demonstrate the same relationship and position of the tubing in the peridural space The laminae and pedicles of the upper two vertebra have been removed (Bonica Courtesy *Anesthesiology*)

Vinyl plastic tubing becomes markedly dry at the point where it emerges from the skin and may break It is then difficult to retrieve the portion inside the patient Although the material is inert and probably produces no serious effects, it is advisable to change the tubing

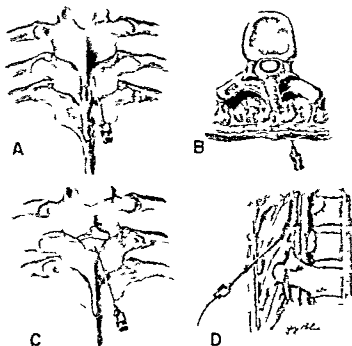


FIGURE 39 *Technic of peridural block in the midthoracic region* by the paramedian route (A) Posterior view showing the needle in contact with the lamina and (C) its advance through the ligamentum flavum (B) A schematic cross section depicting the relationship of the needle to the soft tissue spinous process lamina and the ligament The point of the needle is in the peridural space with the bevel facing cephalad (D) A sagittal section with the laminae and pedicles removed to show the relationship of the needle to the anatomic structures and the tubing in the peridural space (Bonica Courtesy *Anesthesiology*)

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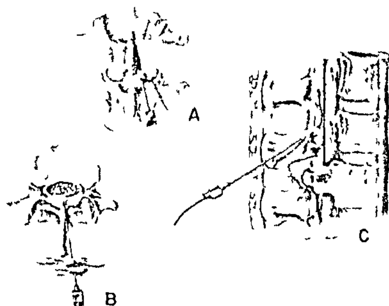


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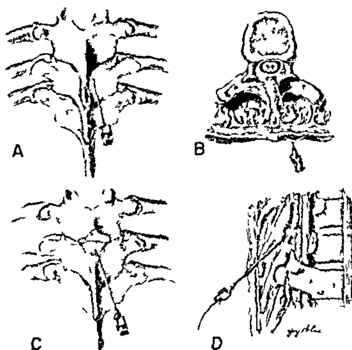


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every two to three days if the block is to be carried for a longer period of time

Agents

In selecting the drug to be employed for epidural block, various properties of each agent must be considered In regard to latency or time necessary to produce extradural block, Nesacaine, Xylocaine, and Cyclaine may be classed together as fast acting (8 15 minutes), procaine, Metycaine, and Intracaine as intermediate acting (15-20 minutes), Pontocaine and Nupercaine as slow acting (well over 20 minutes) Xylocaine has the greatest penetration, with Cyclaine and Chloroprocaine vying for second place The remainder of the drugs are significantly less penetrating

In regard to *duration of anesthesia*, Nesacaine, procaine, Metycaine, and Intracaine can be classed together as drugs producing extradural block of short duration (approximately 1 hour), Nupercaine and Pontocaine effect blocks of long duration (well over 2 hours) Cyclaine and Xylocaine are in the intermediate class (1½-2 hours)

Concerning the *optimal concentration of the drug*, 0 5 to 1% Xylocaine or equiactive concentrations of other drugs are necessary to produce complete sympathetic interruption by the extradural route To assure complete analgesia to pin prick, it is necessary to employ 0 8 to 1% Xylocaine or equiactive concentrations of other drugs, and for somatic motor block it is necessary to use 2% Xylocaine or Cyclaine, 3% Nesacaine, procaine or Metycaine, and 0 25% Pontocaine and Nupercaine These may be considered maximum concentrations of these drugs In some patients even these concentrations fail to produce complete

paralysis of the muscles of the extremities and if such is indicated, it is necessary to inject a second dose after an interval of twenty to thirty minutes (Such an interval is necessary to decrease the risk of toxic reaction and prevent extension of the block)

TABLE V

DOSES OF LOCAL ANESTHETICS FOR EXTRADURAL BLOCK

Agent	*Concentrations Necessary (in Per Cent)*			*Maximum Amount*	
	Block of Sympathetic and Pinprick Only	*Complete Sensory (Pain) Block*	*Complete Motor Block*	*Mg/Kilo*	*Total*
Procaine or Nesacaine	0 5% 1%	1 5% 2 0%	3-4%	10 15	1000
Metycaine or Intracaine	0 75 1%	1 0% 1 5%	3-4%	8 10	1000
Xylocaine or Cyclaine	0 5 0 75%	0 75% 1 0%	2%	5 7	500
Pontocaine or Nupercaine	0 1 0 15%	0 1% 0 2%	0 3%	0 8 1 5	75 100

In order to calculate the volume needed one can consider that 1 to 1 1/2 ml of solution are necessary to effect one neurotome In predicting the extent of the block following peridural injection, the following factors must be considered site of puncture, the volume of solution injected, the concentration and penetration of the local anesthetic drug employed, the speed of injection, the effect of gravity, and the volume and capacity of the peridural space With the patient in horizontal position, the solution disperses equally in every direction, although this may be modified by physiologic and pathologic curvature of the spine The volume of the solution injected is without doubt the most important extrinsic factor affecting the extent of the block, the larger the volume of the injected local anesthetic, the greater the extent of the block Another very significant factor is the position of the patient

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cated by German writers (120) These solutions contain very high concentrations of local anesthetics (e g, 1% Pontocaine) mixed with colloids which make the mixture very heavy and thus limit the spread of the anesthetic and provide longer block The time necessary for induction is too long and the danger of toxic reaction is increased

In my experience, injection of alcohol into the extradural space as recommended by some (120, 139) has failed to produce prolonged effects, and therefore I have abandoned this method The same comment applies to the extradural injection of ammonium compounds and oily preparations, except when these are injected into the sacral canal Apparently this region of the extradural space is more favorable as a depot for such solutions as it allows prolonged exposure of the nerves to their action The use of Proctocaine for this purpose in patients with cancer pain has been reported with good results (140, 141) Five to 10 ml of solution is injected and repeated at daily intervals until the pain is relieved Usually 4 to 6 injections are necessary

Physiologic Effects and Complication

The course of events following extradural injection is very similar to that following subarachnoid block except that their onset is more delayed In about five minutes there is evidence of hypalgesia, vasomotor block, and loss of temperature sense Subsequently, there is progressive loss of pain proprioception, touch sensation, and motor function The effects on touch proprioception, and motor function occur only when maximum concentrations are injected These effects occur first and are most profound near the point of

during and immediately after the injection Although gravity is not as important a factor in extradural block as it is in subarachnoid anesthesia, the use of lateral, Trendelenburg, Fowler, or sitting position is of ad vantage when it is desired to have the solution spread predominantly in one direction

It is obvious that to apply this and other technics properly, it is necessary to know the neurotomes (dermatomes, scleratomes, myotomes, viscerotomes, and angiotomes) involved in the disease process The site of injection, volume of local anesthetic drugs necessary, and the probable resulting extent of anal gesia for some of the more commonly employed seg mental epidural blocks is shown in Figure 34 36

A few words follow concerning the use of other agents and technics for extradural block I have been unable to obtain the prolonged effects from continuous peridural block in treating intractable pain and other chronic conditions reported by Dogliotti and Ciocatto (137) These clinicians noted that if mixed nerves were subjected to the action of concentrated local anesthetics for several days, partial degeneration of the sensory nerves occurred with consequent prolonged interruption By using this type of "differential peridural block they provided relief to 90% of the pa tients thus treated some of whom had intractable pain from cancer After two years the results were considered good in 50% of the patients and fair in another 30% However, although most of our patients received continuous peridural block for a number of days, all had recurrence of pain soon after the block was terminated

Since the introduction of the 'continuous technic" I have abandoned the use of 'plombe' solutions advo

cated by German writers (120) These solutions contain very high concentrations of local anesthetics (e g, 1% Pontocaine) mixed with colloids which make the mixture very heavy and thus limit the spread of the anesthetic and provide longer block The time necessary for induction is too long and the danger of toxic reaction is increased

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injection, farther away from which onset takes a longer time and the effects decrease Like all regional anesthetic procedures, peridural block has no direct effect on the heart, liver, kidneys, and other parenchymatous organs, provided an overdosage of the local anesthetic is not employed and the blood pressure of the patient is maintained within normal limits

The most important complication of extradural block is the production of hypotension which is the expected corollary of vasomotor paralysis The degree of hypotension is closely correlated with the number and the sites of vasomotor segments involved and with such factors as age and physiologic status of the patient The greatest degree of drop occurs when the splanchnic vasomotor segments are involved particularly in elderly patients, and especially in those with marked arteriosclerosis, dehydration, hypovolemia and other factors which effect cardiovascular function

TABLE VI

SUMMARY OF TECHNICS OF EXTRADURAL (PERIDURAL) BLOCK

Indications	*Site of Injection*	*Volume of Local Anesthetic (ml)*
Posttraumatic or Postoperative Pain		
Upper Extremity	C8	5 8
Chest	T5 or T6	5 8
Upper Abdomen	T8	5 8
Lower Abdomen	T11	5 8
Lower Extremity	L4	6 10
Reflex Sympathetic Dystrophy		
Upper Extremity	C8	5 8
Lower Extremity	L4	6 10
Peripheral Vascular Disease		
Upper Extremity	T1	4 6
Lower Extremity	L2	4 6
Visceral Disease		
Thoracic	T3	5 8
Upper Abdomen	T8	5 8
Lower Abdomen	T12	5 8
Pelvis	S3	8 10
Musculoskeletal and Cancer Pain	Various sites	Variable

Generalized toxic reactions may occur, probably as a result of the greater vascularity of the peridural space and the not infrequent laceration of the venous plexus by the invading needle or catheter For this reason the volume and concentration of the drug should be limited to therapeutic amounts

Other complications include accidental perforation of the dura arachnoid with possible development of post puncture headache Of course, if the invasion of the subarachnoid space is not detected and there is inadvertent subarachnoid injection of large amounts of local anesthetics, respiratory paralysis and perhaps serious cardiovascular dysfunction may follow Neurologic sequelae are rare with this technic although they may occur in the hands of the inexperienced or careless operator

CHAPTER XII

SUBARACHNOID BLOCK

SUBARACHNOID BLOCK in one form or another may be employed as a diagnostic, prognostic and therapeutic measure in many disorders involving the abdomen, trunk, and lower extremity Although there has been a definite trend to use this method less and less, the standard technic offers certain advantages over other methods such as extradural, paravertebral, and peripheral blocks These advantages are simplicity and facility of administration, rapid onset of effects, and certainty of action These, together with minimal chance of complications, make is particularly useful to physicians who are inexperienced with other forms of autonomic and somatic nerve blocks In patients where blocks are needed to establish the diagnosis, or to prognosticate the effects of surgical procedures, subarachnoid block serves as the surest test of the effect of interrupting the pathways by chemical means Whenever there is uncertaintv as to the results produced with paravertebral sympathetic, paravertebral somatic, or peripheral nerve block the case should not be dismissed unless the results have been confirmed with subarachnoid block

The sequence of physiologic effects following subarachnoid injection of local anesthetic drug is similar

to that described under extradural anesthesia except that the onset is more rapid The difference in vulnerability of various fibers permits a differential spinal block and makes possible the clinical application of this method in the management of many disorders

Complications of subarachnoid block include post-puncture headache, which is perhaps the most important, and hypotension, the degree of which depends on the number of vasomotor segments involved In addition, there is always the remote hazard of producing arachnoiditis, myelopathy, radiculopathy, or other neurologic squelae Although admittedly these complications are extremely rare, they have nevertheless prompted many clinicians to avoid this method, particularly since the increase in popularity of extradural anesthesia The risk of these sequelae can be obviated or minimized by using extreme care in the aseptic technic In this connection it should be stressed that the subarachnoid space should be treated as is the peritoneal cavity (142) The equipment and the drugs which are used to inject into the subarachnoid space should be sterilized by heat sterilization (autoclaving) and not by soaking them in antiseptic solution, and extreme care should be taken to avoid introduction of some of the antiseptic solution used for the skin into the subarachnoid space If the continuous technic is employed, a proper dressing should be applied, and the patient should be given prophylactic doses of antibiotics

For circumstances which require block of brief duration (one hour or less) the single injection is adequate and has the advantage of producing slightly less trauma than the continuous technic On the other hand in the skillful insertion of an 18 gauge, thin-

walled needle and the passage of plastic tubing through it, is inherent only a little additional trauma, and this practice affords the outstanding advantages of controllability of intensity, extent and duration of block. If the catheter is used, it is important not to advance it more than 3 to 5 cm. in order to avoid the risk of injuring the nerve roots. Because there is the greater risk of infection when a catheter is left in the subarachnoid space, continuous subarachnoid block is rarely carried out for more than a few hours. For longer blocks the extradural method is preferred.

TABLE VII

DOSES OF LOCAL ANESTHETICS FOR SUBARACHNOID BLOCK

Agent	*Concentrations Necessary (in Per Cent)*			*Dosage Range*
	Block of Sympathetic and Pinprick Only	*Complete Sensory (Pain) Block*	*Complete Motor*	
Procaine or Nesacaine	0.3%-0.5%	2%	5%	25-150
Metycaine or Intracaine	0.2%-0.5%	2%	4-5%	25-100
Xylocaine or Cyclaine	0.2%-0.4%	1-1.5%	3-4	25-75
Pontocaine or Nupercaine	0.03%-0.05%	0.075-0.1%	0.2-0.25%	2.5-10.0

CLINICAL APPLICATIONS

Subarachnoid block may be employed as a diagnostic, prognostic or therapeutic measure in many of the conditions mentioned in the preceding chapters in connection with extradural block, somatic, and autonomic nerve blocks. This technic is also particularly useful for the production of certain interruption of sympathetic and parasympathetic pathways in disorders involving the lower extremity, pelvis, abdominal

viscera and trunk.* It is used in the management of peripheral vascular disorders, especially those in which there is predominance of vasospasm and pain. It may also be employed for the same reason in causalgia and other reflex sympathetic dystrophies of the lower extremity. As is well known, the block must be made to extend to at least the 10th thoracic level in order to interrupt all the sympathetic fibers to the extremities.

Continuous subarachnoid block has been of particular value as a diagnostic-prognostic procedure in patients with post amputation pain, including painful phantom limb. This procedure is essential prior to carrying out chordotomy in these patients. By using the continuous technic and drugs with short action such as procaine the block can be extended two or three segments cephalad with each injection until the pain is relieved. In order to ascertain the complete effects of each dose, the injections should not be made more frequently than at 30 minute intervals. In several of our patients local infiltration of the stump, paravertebral somatic nerve block, paravertebral sympathetic block, extradural block to the 10th thoracic level, and single dose spinal block had failed to produce relief. When the continuous subarachnoid technic was carried out in one of these patients, it was noted that relief of pain was complete when the block was extended to the 5th thoracic segment. This was very valuable information to the neurosurgeon in helping

*It may be recalled that the cell body of preganglionic sympathetic fibers is located in the anterolateral column of the spinal cord and that their axons leave by way of the anterior roots from the level of the 1st thoracic to that of the 2nd lumbar segments inclusive. They then pass to the corresponding spinal nerves and as white rami communicantes reach the paravertebral sympathetic trunk. Thus the entire sympathetic outflow to the body leaves the central nervous system bilaterally through these and only these segments.

him decide the level of chordotomy In two other patients analgesia was extended to the upper cervical segments without subjective relief of pain As this was carried out on three different occasions with similar results, the patients were considered not to be candidates for chordotomy

Subarachnoid block may also be employed as a diagnostic, prognostic, and therapeutic procedure in visceral disease in the manner described for extradural block In megalocolon and paralytic ileus this technic has been used for many years, both as a diagnostic and therapeutic measure Some prefer this technic in managing patients with eclampsia because it provides more prompt and more certain results than any other method

Knight has reported the use of subarachnoid block in the 4th thoracic level as a therapeutic measure during thyroidectomy (143) The beneficial effects of such a procedure are based on the assumption that hyperadrenalism plays a part in the syndrome of hypo thyroidism and that the subarachnoid block decreases sympathetic over activity by blocking neurogenic stimuli to the adrenal gland Sarnoff and Farr (144) have also reported the use of subarachnoid block in the therapy of pulmonary edema due to cardiac decompensation By effecting peripheral vasodilatation and pooling of the blood in the lower portion of the body, the block causes a decrease in the venous return to the right heart, lessening its load and giving it an opportunity to catch up As previously mentioned, in the few cases where we have used this and other methods for this purpose, our results have been poor and there fore I cannot recommend it

Continuous subarachnoid block has been used as the most certain method of prognosticating the effect of sympathectomy in patients with hypertension The comments made on page 186 concerning the use of this or any other block method for this purpose apply here

Differential Spinal Block

Sarnoff and Arrowood have developed a modification of the continuous technic, which entails the injection of dilute solutions of local anesthetics in order to produce a preferential or differential spinal block (145) As originally described, the technic is carried out as follows The initial dose, which consists of 15 cc of 0 2% solution (30 mgm) of procaine, is allowed to run in for about three minutes and thereafter at a rate of 15 drops per minute (0 6 cc or 1 2 mgm) untill the block is obtained up to the desired segment Subsequently, the rate of administration is determined by the duration and level of block desired By this method they were able to preferentially block vasomotor, sudomotor, and visceromotor fibers of the sacral (parasympathetic) and thoracolumbar (sympathetic) outflows as well as fibers which carried pinprick sensation and stretch afferents, while they were able to spare fibers which carried touch, position sense, vibration sense, somatic motor, and pain other than pinprick

Sarnoff and Arrowood used this technic as a research tool and studied the neurophysiology of nerve fibers of various sizes and myelinization and correlated their findings with those of earlier workers who had showed that fibers of mixed nerves are differentially affected by local anesthetic drugs (146-149) In addition, they elucidated the mechanism of hypotension

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Subarachnoid block may also be employed as a diagnostic, prognostic, and therapeutic procedure in visceral disease in the manner described for extradural block In megalocolon and paralytic ileus this technic has been used for many years, both as a diagnostic and therapeutic measure Some prefer this technic in managing patients with eclampsia because it provides more prompt and more certain results than any other method

Knight has reported the use of subarachnoid block in the 4th thoracic level as a therapeutic measure during thyroidectomy (143) The beneficial effects of such a procedure are based on the assumption that hyperadrenalism plays a part in the syndrome of hypothyroidism and that the subarachnoid block decreases sympathetic over-activity by blocking neurogenic stimuli to the adrenal gland Sarnoff and Farr (144) have also reported the use of subarachnoid block in the therapy of pulmonary edema due to cardiac decompensation By effecting peripheral vasodilatation and pooling of the blood in the lower portion of the body, the block causes a decrease in the venous return to the right heart, lessening its load and giving it an opportunity to catch up As previously mentioned, in the few cases where we have used this and other methods for this purpose, our results have been poor and therefore I cannot recommend it

ticularly true when using the usual technic of subarachnoid block to anesthetize several thoracic segments, which are affected only after all the segments below have been blocked Consequently the undesirable vascular effects such as hypotension are of a much greater degree In order to obviate this disadvantage, many technics have been devised to produce segmental subarachnoid block Notwithstanding the technical difficulties encountered, segmental subarachnoid block does have the advantage of affecting only the desired segments, and in certain painful conditions it is an excellent diagnostic prognostic procedure prior to the injection of alcohol or to rhizotomy

The technic of establishing segmental subarachnoid block requires exact knowledge of the segments to be affected and their relation to the spinal cord and vertebral column It necessitates the use of small volumes in order to limit the spread of analgesia and of weak solutions because usually only analgesia (and not muscular paralysis) is desired The anatomy of the thoracic portion of the vertebral column, of course, presents greater technical difficulties

Segmental block of the upper cervical segments should be avoided because of the serious risk of phrenic (respiratory) paralysis For segmental block in other regions the puncture is done at such levels as to produce a band of analgesia in the affected neurotomes The volume and concentration of the solution to be injected to produce segmental block depend upon the number of segments to be blocked I usually prefer to inject undiluted 1% Pontocaine solution which contains 10 mgm per cc Usually 0 2 to 0 4 cc (2 to 4 mgm) will produce a band of analgesia involving 4 to 6 segments This of course, depends upon the force

that occurs following spinal anesthesia showing that it is predominantly due to block of the vasoconstrictor fibers and not to skeletal muscle paralysis as some writers had suggested Moreover, they found that cutaneous and stretch reflexes could be blocked with out impairing position sense They employed this tech nic in investigating intestinal dyskinesia, colic atony, and postamputation pain

In my experience the concentrations used by them have infrequently proved insufficient to produce a complete sympathetic paralysis Therefore, in order to be certain that all of these fibers are blocked, it is suggested that the procedure be carried out with 0 5% procaine or equiactive concentrations of other local anesthetic drugs Such concentrations still spare touch, position sense, vibration sense, and the most important skeletal motor fibers

This is a valuable diagnostic adjunct in helping the physician to determine the mechanism of the pain and to predict the effects of sympathectomy It should be noted that the same effects may be produced with extradural block as well as with peripheral nerve block

The block may also be used as a therapeutic meas ure If 0 5% procaine or an equiactive concentration of local anesthetic drug are ineffective in relieving pain, it is advisable to gradually increase the concentration until the patient experiences relief Usually this can be accomplished with a concentration which is still not sufficient to block skeletal muscle and proprioception

Segmental Subarachnoid Block

One of the disadvantages of spinal anesthesia is that in order to affect a few segments, many others are unnecessarily and unavoidably affected This is par-

The technic of producing segmental subarachnoid block in the thoracic region by advancing a catheter from the lumbar region cephalad, as originally described by Saklad and his associates (150), is to be condemned because there is too great a risk that the catheter in being advanced may damage the spinal cord or in being withdrawn may avulse nerve roots round which it may have become looped The use of this technic for the injection of absolute alcohol as a therapeutic measure for intractable pain has not gained widespread use for the same reason

Subarachnoid Alcohol Block

Subarachnoid alcohol block, when properly carried out, produces a chemical posterior rhizotomy which may be used as a good substitute for neurosurgical operations in patients who are in poor physical condition or in those who refuse operation In view of the destructive nature of this procedure and the complications which sometimes occur following it, the method should be reserved for patients with severe, intractable pain who cannot be managed in any other manner

Since all pain impulses, including those from the viscera, enter the spinal cord through the posterior roots and since the roots of any spinal nerve below the cervical region can safely be blocked with this procedure, the wide scope of its applicability is obvious It is particularly useful in relieving cancer pain caused by pressure of somatic nerve or nerve roots as produced by metastatic lesion of the vertebrae and tumors in the paravertebral regions

Although descriptions of technic are beyond the scope of this monograph, the importance and complexity of subarachnoid alcohol block are such that a

and rate of injection Smaller or larger volumes may be used as necessary With this drug a block lasting one to two hours is produced

It should be stressed that subarachnoid puncture above the 1st lumbar vertebra is considerably more difficult to perform and submits the spinal cord to the *serious risk of damage For this reason, this technic* should be used only by those physicians who have had great experience in regional anesthesia, especially in performing lumbar subarachnoid block and spinal epidural block at various levels One of the greatest difficulties lies in the aspiration of cerebrospinal fluid to ascertain entrance into the subarachnoid space To overcome *this difficulty it is best to place the patient* in the lateral position and raise the head of the table well above the site of puncture Moreover, it is best to identify the extradural space by the usual lack of resistance test After reaching this point, the needle is then advanced a few millimeters with a syringe attached to the hub and continuous aspiration is applied *so that one is able to discern as soon as the point* of the needle enters the subarachnoid space This will decrease the chance of accidentally entering the spinal cord substance

Thoracic segmental subarachnoid blocks interrupt the sympathetic fibers and result in vasodilatation and hypotension, the degree of which depends on the number of segments involved It is most important to treat the hypotension, unless the block is being done to prognosticate the effect of sympathectomy on existing hypertension In addition, means should always be available to do artificial respiration in case the respiratory muscles are involved

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few brief remarks are warranted Since the effectiveness of this procedure depends on the hypobaricity and neurolytic effects of the alcohol, it is necessary to place the patient in such a way that the alcohol, when injected into the subarachnoid space, bathes exactly the nerve roots which are to be influenced The site of puncture is best made at the level at which the involved nerve roots join the spinal cord The patient is placed on the side opposite to the one to be affected, with a pillow under the body and the operating table flexed so as to produce a scoliosis with the maximum corresponding to the nerve roots conveying the pain The patient's body is turned forward 45 degrees so that the upper posterior roots are horizontal, as depicted in figure 41

The 22 gauge spinal needle may be inserted in the midline or paramedially In order to better discern the entrance of the needle into the subarachnoid space and thus to prevent damage to the spinal cord, the peridural space should be located first by the lack-of-resistance test The needle is then advanced a few millimeters with continuous attempts to aspirate until the point enters the subarachnoid space at which time fluid will appear in the barrel of the syringe

If the pain involves many segments, it is best to introduce two or three needles so as to permit the injection of small volumes (0 5 ml per needle) The solution is injected very slowly so that two to three minutes are consumed in injecting 0 5 ml of alcohol This is facilitated by the use of 1/2 ml tuberculin syringe The use of large doses to effect widespread analgesia when the pain involves many segments is fraught with danger and complication

It is most important to instruct the patient not to

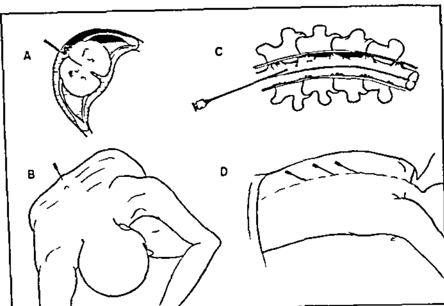


FIGURE 40 Diagram showing the position of the patient for *subarachnoid alcohol* block in the thoracic region Note that the patient is placed in the lateral prone position so that the posterior surface of the back makes an angle of 45 degrees with the superior surface of the table (B) One or two pillows are placed under the region to be blocked and the table flexed so as to produce a scoliosis of the spine with a maximum curve corresponding to the nerve roots conveying the pain This will place the posterior (sensory) nerve roots involved in conducting pain uppermost (A) with the head and extremities lower than the point of injection (C) Shows a longitudinal section showing diffusion of the hypobaric alcohol to involve the uppermost sensory roots (D) Note that three needles are used in order to permit the injection of small volumes of solution and thus minimize complications

move during and for one hour following the injection, explaining the importance of this in avoiding complications The use of a narcotic analgesic given intravenously just prior to the injection may minimize the discomfort After the injection is completed it is

advisable to administer more analgesic or/and thiopental to effect a quiet sleep in the patient and make immobility easier to tolerate

Complications which may occur following this procedure include weakness or paralysis of the extremities, bladder, and anal sphincters Bladder paralysis, which is the most serious, must be treated by indwelling catheterization until it disappears These are serious complications which emphasize that the procedure is not without danger However, since these complications are more prone to occur when the injection involves the lumbosacral region, and can be avoided when the injection is carried out above this area, and since many patients who require the block already have weakness or paralysis of the sphincters or of the extremities or both, consideration of these complications should not deter one from using this method in indicated cases On the other hand, these considerations emphasize the importance of reserving this technic for patients with intractable pain due to cancer or other chronic conditions For patients who can tolerate neurosurgical operations and are expected to live longer than two to three months, rhizotomy or chordotomy is preferred

The duration of pain relief varies from several weeks to many months and occasionally years Statistics indicate that the average duration is three to five months, usually sufficiently long to afford relief until death of the patient Of course if the patient lives longer than the analgesia lasts the block can be repeated

In my experience complete relief of pain is rarely seen following one injection and it is usually necessary to repeat the procedure two or three times By em

ploying this method in this fashion in our clinic, a little over 50% of the patients experienced good relief, about 30% experienced fair relief, about 20% derived no benefit Although these results compare favorably with neurosurgical procedures, I wish to stress that I favor surgery over block in patients who can tolerate the operation because the former produces more specific and lasting results

CHAPTER XIII

BLOCK OF CRANIAL NERVES

BLOCK OF ONE OR MORE of the cranial nerves can be applied in the management of many clinical dis orders The cranial nerves particularly amenable to blocking include the 5th (trigeminal), 7th (facial), 9th (glossopharyngeal), 10th (vagus), 11th (spinal accessory), and 12th (hypoglossal) The procedure is particularly useful in the management of pain of the so called idiopathic neuralgias, of pain due to me chanical neuropathy, neuritis, and of pain due to cancer and other neoplastic lesions of the head In addition, nerve blocks constitute a very effective ad junct in the management of certain autonomic dis turbances which involve pathways associated with one or more of these cranial nerves These disturbances include the Marcus Gunn phenomenon, the Heiden hain phenomenon, the Vulpian phenomenon, the auriculotemporal syndrome, gustatory sweating, and the phenomenon of crocodile tears

BLOCK OF THE TRIGEMINAL NERVE OR ITS BRANCHES

Since the trigeminal nerve supplies the sensory fibers to the entire face and the anterior two thirds of the head, it becomes involved in many painful and

autonomic disturbances Consequently block of the gasserian ganglion or one of the branches of the nerve is one of the most frequently applied Moreover, because most of the nerve is purely sensory and since the major branches are anatomically separated from each other by some distance and by structures, it is feasible to interrupt one of them specifically without involving other major nervous pathways These procedures are therefore of special value in aiding the differential diagnosis of various painful conditions, such as tic douloureux of the trigeminal and glossopharyngeal nerves, atypical facial neuralgia, migraine headaches, pain due to malignancies, and herpes zoster Properly carried out, the procedures can be of great help in differentiating pain due to intracranial pathology from pain due to conditions in the face

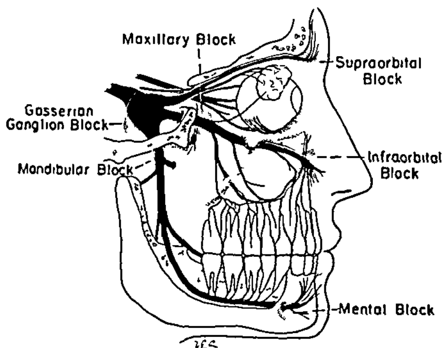


FIGURE 41 Diagram showing the *anatomy and distribution*

(Continued on next page)

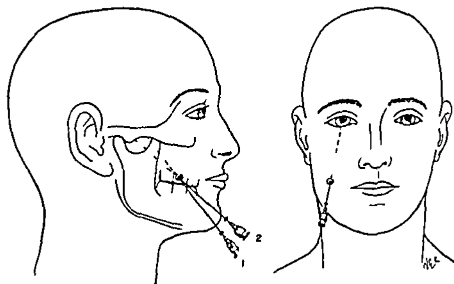


Figure 42 *Technic of blocking the gasserian ganglion* and the mandibular nerve by the anterolateral (Hartel) approach The needle is inserted through a skin wheal which is on the skin overlying the 2nd upper molar tooth and advanced in a direction so that when it is viewed from the side its point is directed to the midpoint of the zygomatic arch and when viewed from the front it is directed to the pupil of the ipsi lateral eye It is advanced until it contacts the infratemporal plate lateral to the base of the pterygoid process just anterior to the foramen ovale The depth mark is then set 1 5 cm from the skin surface the needle withdrawn until its point is in the subcutaneous tissue and is then reinserted so that its point will eventually go through the foramen

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of the trigeminal nerve and the optimal site of injecting it (stippled areas) Gasserian ganglion block is accomplished by passing a needle through the foramen ovale and into the gas serian ganglion maxillary nerve block is accomplished in the pterygopalatine fossa just after the nerve passes through the foramen rotundum mandibular block is accomplished just below the foramen ovale supraorbital block is accomplished at the supraorbital ridge, infraorbital block accomplished at the infraorbital foramen or canal and mental block at the mental foramen (See Figure 42 and compare with Figures 43 (page 281) and 44 (page 285)

Gasserian Ganglion Block

When the condition is extensive and involves the major branches of the trigeminal nerve, one of the optimal sites of injection is into the gasserian ganglion. However, this procedure is considerably more difficult to carry out than the blocking of one of the major divisions or smaller branches of the nerve, and is inherent in more serious complications. The most important of these is inadvertent subarachnoid injection which invariably produces unconsciousness, cardiovascular collapse, and palsy of other cranial nerves. These complications, especially serious if they follow alcohol injections since the effects may be permanent, should be avoided at all costs. On the other hand, alcohol injection of the gasserian ganglion destroys sensory nerve cells and theoretically effects permanent interruption without affecting motor neurons since the cell bodies of the latter are located in the pons. This procedure is therefore effective in managing severe, intractable pain in patients in poor physical condition.

Trigeminal Neuralgia

Gasserian ganglion block is useful in the management of major trigeminal neuralgia or tic douloureux. This condition, of unknown etiology, is manifested by sudden intense, stabbing, shooting pain in some portion of the face. The bout of lancinating pain is very brief and is usually precipitated by stimulation of a trigger region by drinking, talking, washing the face, or brushing the teeth. The characteristic pain is usually limited to one or more branches of the trigeminal nerve.

In the management of trigeminal neuralgia analgesic blocks offer certain advantages. When properly

executed, they effect immediate and complete relief of pain Their inherent risk is less than that of neuro surgical operation, and this fact makes them particu larly appropriate for elderly, poor risk patients In patients who are dehydrated, malnourished, and greatly debilitated because the presence of a trigger zone makes eating and drinking difficult, injection therapy may effect sufficient relief to permit a normal food intake with restoration of general nutrition and health prior to operation

Blocks also aid the physician in confirming or dis proving diagnoses They furnish the patient proof that permanent interruption by nerve section will completely relieve the pain, and they afford him an opportunity to become acquainted with the numbness and paresthesia which follow retrogasserian neurotomy and thus keep him to decide whether or not to undergo the operation Some patients are greatly annoyed and complain bit terly of the anesthesia and paresthesia that follows the operation unless they have been properly informed prior to surgery and the effects of the section have been duplicated with a preliminary block

Since in many instances the symptomatology is limited to a small branch of the nerve, such as the infraorbital, mental, or frontal, the block of the branch in question is usually adequate Usually 0 5 to 1 ml of local anesthetic and subsequently alcohol are suffi cient to block these nerves These limited procedures are particularly useful in patients in very poor physical condition who may not tolerate more radical injections at the base of the skull In patients who have pain in the territory of more than one of the branches of the major division, injection of the maxillary or mandibu lar nerves as they emerge from the base of the skull

may be necessary In the event that symptomatology involves more than one of the major divisions, it may be advisable to inject the gasserian ganglion This technic, of course, produces analgesia of the entire ipsilateral half of the face and the anterior two thirds of the head

Injection of alcohol into the ganglion theoretically effects permanent interruption because the cell bodies are destroyed Some writers have reported cases of patients who have obtained relief of pain for as long as thirty years, and many others who have gone six to twenty years following their injections It would appear that this procedure should be preferred to the operation in all instances However, the procedure is followed by anesthesia of the cornea with consequent neuroparalytic keratitis similar to that following operation In view of this and other possible complications of gasserian ganglion block and since in many of cases the procedure does not provide permanent complete relief because of incomplete destruction of all the cell bodies, its use as a therapeutic measure should be considered only under certain circumstances when the life expectancy is short, when the patient's condition is too poor to warrant an operative procedure, or when infection of the mastoid cells or other tissues, should they be accidentally traumatized at operation, carries the danger of meningitis Otherwise the operative procedure is the method of choice and should be carried out for permanent cure after the patient has been subjected to one or at most two alcohol injections

The injection of the gasserian ganglion with boiling water as another method of providing long-lasting relief without some of the complications of alcohol injection has been reported (151) Although sufficient

time has not elapsed to permit proper evaluation of this procedure, the results thus far have been encouraging It should be stressed, however, that this method should be considered as a palliative procedure There is only one thoroughly proven method of cure—retrogasserian neurotomy In the average patient one injection of alcohol or boiling water should be performed, but when the pain returns the patient should be persuaded to undergo the curative operation

Cancer Pain

Block of the gasserian ganglion is even more useful in the management of severe, intractable pain due to cancer involving the anterior two thirds of the head As is well known, the face, mouth, and throat are frequent sites of neoplasm, which not infrequently produces severe pain by expansion and pressure on one or more of the cranial nerves The face is involved by tumors which commonly arise from structures about the mouth, nose and paranasal sinuses Fortunately, these usually spare the eye and, therefore the pain may be controlled by injecting the 2nd and 3rd division of the trigeminal nerve However, if for any reason, analgesia cannot be produced by injection of these nerves, the physician must not hesitate to inject the gasserian ganglion because relief of pain must be obtained for the patient even at the price of keratitis The problem here is quite different from that in patients who have tic douloureux, in whom the life expectancy is long and a corneal ulcer a serious complication

Gasserian ganglion block is particularly useful if the lesion involves structures which are supplied by more than one of the major divisions of the 5th cranial

nerve This technic has advantages over mandibular and/or maxillary nerve block in such cases in that it produces a widespread field of analgesia into which the cancer can spread without producing more pain

Occasionally the tumors of the face and head cause a burning discomfort in addition to the severe neuralgic pain Such pain is usually diffusely located over one side of the head, the eye, the teeth, and the lower, and sometimes the upper jaw, the temporal region, and the nape of the neck It indicates block of the cervicothoracic sympathetic chain in addition to gasserian ganglion block After repeated injections with local anesthetic drug, this procedure may be carried out with phenol or alcohol, as mentioned on page 87

Neuralgia Due to Other Causes

Occasionally pain in the distribution of the entire trigeminal nerve is due to other demonstrable pathologic processes such as vascular lesions, inflammatory disease, systemic disorders, herpes zoster, neuritis, trauma and various others, which produce an inflammatory, mechanical, or chemical neuropathy The pain in these conditions is usually continuous, boring, and aching in character, and is not provoked by stimulation of trigger areas, as occurs in trigeminal neuralgia Occasionally it is sufficiently severe to warrant blocking of the gasserian ganglion, either as a diagnostic, prognostic, or therapeutic measure It is again stressed that in such cases an attempt should be made to ascertain the cause and if possible eliminate it If this is impossible a therapeutic block with long-lasting local anesthetic or even alcohol may be justified

Ophthalmic Nerve Block

Block of the ophthalmic nerve as it emerges through the superior orbital fissure can be employed as a differential diagnostic procedure It should almost never *be attempted with alcohol as a therapeutic* measure because it is in very close proximity to the optic, trochlear, and oculomotor nerves, and therefore, inherent in very serious complications The only time such a procedure is justified is in the control of severe, intractable pain due to inoperable cancer in a patient who has only a few weeks or months to live The same comment applies to the block of the ethmoidal nerves before passing into the anterior ethmoidal foramen on the medial wall of the orbit

Frontal and Supraorbital Nerve Block

Block of the frontal and supraorbital branches of the ophthalmic nerve as they emerge from the orbit over the supraorbital ridge is a very useful procedure in managing any of the previously mentioned painful conditions It may be used as a diagnostic measure prior to avulsion of these nerves in the treatment of tic douloureux, of cancer, and of post herpetic neuralgia Alcohol block of these terminal branches of the ophthalmic nerve is similarly useful in providing prolonged analgesia However, it should be stressed that very small amounts (0 25 to 0 5 ml) should be employed lest the neurolytic agent diffuse into the orbit and produce serious complications

Block of the Maxillary Nerve and its Branches

Injection of the maxillary nerve in the pterygopalatine fossa after it emerges through the foramen rotundum can be carried out by the lateral, or anterolateral

extra-oral routes, by the orbital route, or by the oral route It is frequently employed as diagnostic prognostic procedure in the management of trigeminal neuralgia, cancer pain, and other painful conditions of

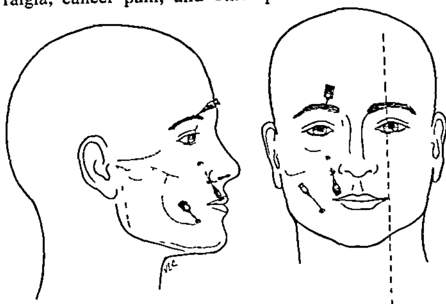


FIGURE 43 Diagram depicts the *technics of blocking the supraorbital infraorbital and mental nerves* as they emerge from their respective bony cavities and enter the subcutaneous structures *Supraorbital block* is carried out as the supraorbital nerve and supratrochlear nerve leave the orbit by curving around the supraorbital margin about 2 5 cm from the midline To block the *infraorbital nerve* a wheal is formed 1 cm lateral to the ala nasa (approximately 2 5 cm from the midline) and advanced in a superior posterior and slightly lateral direction The needle is advanced until its point enters the infraorbital canal through the infraorbital foramen and paresthesia is elicited The *mental nerve* is blocked at its exit through the mental foramen Note that the wheal is formed superolateral to the foramen and the needle advanced at such an angle so that it will pass into the mental canal The line on the left of the figure indicates that the supraorbital notch the infraorbital foramen and the mental foramen are located in a straight line and approximately 2 5 cm parallel to the midsagittal plane

the middle portion of the face, specifically when it is limited to the upper jaw, teeth, maxillary sinus, and palate Maxillary nerve block with alcohol lasts an average of 15 months

Maxillary nerve block is slightly more difficult to carry out than mandibular nerve block, and extreme care must be exercised, particularly when injecting alcohol For the latter procedure, it is necessary to contact the nerve directly with the needle, and to limit the total amount of alcohol injected to no more than 1 ml , lest the neurolytic solution diffuses through the inferior orbital fissure to the floor of the orbit and damage the oculomotor nerve with consequent dysfunction of extra ocular muscles and strabismus

Block of Sphenopalatine Ganglion

Block of the sphenopalatine ganglion in the pterygopalatine fossa is a useful diagnostic and therapeutic measure in the management of so called *Sluder's neuralgia* and other peculiar forms of *atypical facial neuralgia* This condition, formerly thought to represent neuritis of the sphenopalatine ganglion or the vidian nerve or petrosal nerve, is now considered to be caused most frequently by distension of the internal maxillary artery and its branches This is not a true neuralgia, but is a condition characterized by a steady, diffuse, deep pain with an aching quality and a distribution which is seldom, if ever, limited to the domain of any of the cranial nerves It is usually located in the nose, around and deep within the eye, in the upper and lower jaw, in the malar and temporal region in front of and through the ear, and in the occipital region, and sometimes radiates to the neck and shoulder Occasionally it is associated with such autonomic phenomena as lacrimation, flushing, corneal and conjunctival injec

tion, edema, enophthalmus, photophobia and even blurred vision, and sometimes by rhinorrhea and nasal obstruction

The management of this pain should include a thorough search for, and elimination of, any possible etiologic factors, such as psychosomatic disorders, infectious process of the bones or soft tissue of the face, dental disorders, ocular pathology, or dysfunction of the temporomandibular joint Nerve blocks may aid in differential diagnosis, but they should never be employed as therapeutic measures for they are not only useless, but frequently aggravate the problem, especially if alcohol is injected Since emotional stress, tension, or anxiety in many instances is the precipitating or aggravating factor, psycho therapy is necessary Vasoconstrictors are effective in reducing vascular distension Associated muscle spasm may be relieved with local infiltration and physical therapy

Pterygopalatine fossa block of the maxillary nerve and sphenopalatine ganglion is also useful as a diagnostic prognostic procedure in the management of *Heidenhain s phenomenon* This condition is a pseudomotor response characterized by retraction of the upper lip when the maxillary nerve is stimulated (95) It has been suggested that this and other pseudomotor responses consequent to injury of one of the cranial nerves are produced by proprioceptive stimuli arising from movements of muscles of the face, jaw, and tongue with stimulation of the mesencephalic nucleus of the 5th nerve or the reticular substance close to the intramedullary portion of the facial nerve This sets off an autonomic (parasympathetic) discharge and liberates acetylcholine which produces a slow tonic

contraction of the muscles of the upper lip Since block in the pterygopalatine fossa interrupts parasympathetic, sympathetic, and somatic afferent fibers, it should interrupt the reflex arc and thus prevent the occurrence of the response

Pterygopalatine fossa block of the sphenopalatine ganglion is also a very useful diagnostic and prognostic procedure in the management of the *phenomenon of "crocodile tears"* This condition occurs after partial injury to the central portion of the facial nerve and is characterized by excessive tear secretion on mastication of bitter, sour, or salty foods (95) Interruption of the parasympathetic pathways in the sphenopalatine ganglion prevents such phenomenon and if the severity of the condition warrants a prolonged interruption, it may be advisable to give the patient a trial with alcohol block

Infraorbital Nerve Block

Block of the infraorbital nerve, either within the infraorbital canal or as it emerges through the infraorbital foramen (Fig 43), is very useful in managing tic douloureux, especially in patients who are in extremely poor physical condition The only complication associated with this procedure is hematoma of the face, but this may be minimized by the use of a fine 25-gauge needle and the application of pressure immediately after withdrawing the needle This procedure may also be used in treating the other painful disorders of the upper lip, lateral portion of the nose, and the lower lid

Mandibular Nerve Block

Block of the mandibular or 3rd division of the trigeminal nerve (Fig 44), as it emerges through the

foramen ovale, is perhaps the most useful of all the block procedures of cranial nerves This is so not only because the 3rd division is frequently involved in pain-

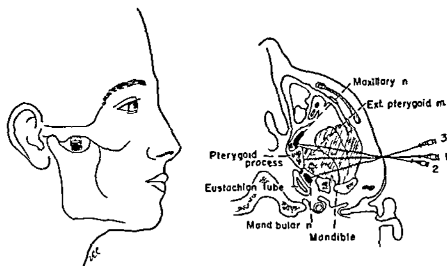


FIGURE 44 Diagram depicting the *technic of maxillary and mandibular nerve block* by the lateral extra oral route Figure on the left indicates point of entrance into the skin just below the midpoint of the zygomatic arch Figure on the right shows a schematic cross section The point of the needle (needle 1) is impinging on the lateral pterygoid plate To carry out maxillary nerve block the needle is withdrawn until its point is in the subcutaneous region and then reinserted so that it will pass slightly anterior and superior and advance until its point enters the pterygopalatine fossa and contacts the maxillary nerve therein (needle 2) In carrying out mandibular nerve block needle 1 is withdrawn and reinserted in a direction slightly posterior It is advanced until its point contacts the mandibular nerve just below the foramen ovale (needle 3) After contacting each nerve and eliciting paresthesia 1 to 2 ml of solution is injected

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Mandibular Nerve Block

Block of the mandibular or 3rd division of the trigeminal nerve (Fig 44) as it emerges through the

follows injury of the oculomotor nerve and is characterized by abnormal upward retraction of the upper eyelid during mastication (95) It has been suggested that movement of the muscles of mastication initiates afferent stimuli, which are propagated over the proprioceptive fibers of the mandibular nerve to the mesencephalic nucleus Here they initiate efferent discharges which pass via parasympathetic fibers associated with the oculomotor nerve and effect release of acetylcholine, resulting in marked contraction of the eyelids Block of the mandibular nerve (including the motor root), with a local anesthetic drug and subsequently with alcohol, can be employed to stop the associated movements In some instances, intracranial section of the 3rd division has been carried out in order to relieve permanently the "jaw winking" phenomenon after indication by prognostic blocks that such interruption would be beneficial

Auriculotemporal Nerve Block

Block limited to the auriculotemporal branch of the mandibular nerve is difficult to carry out because of the lack of bony landmarks However, since the nerve is superficial to the parent structure, it is occasionally contacted during the advance of the needle to the foramen ovale, producing paresthesia limited to the ear and the temporal region In such instances, the injection of small volumes will produce a block limited to this nerve This technic is especially useful in diagnosis and prognosis of the *auriculotemporal syndrome* a disorder which follows injury to branches of the auriculotemporal nerve produced by inflammatory reaction or trauma during surgery of the parotid gland It is

ful conditions and other disorders, but also because it is more accessible than the maxillary branch and its block is therefore easier to carry out and is followed by fewer complications The serious disadvantage of this technic is that it is followed by involvement of the motor fibers, which effects paresis or paralysis of the ipsilateral muscles of mastication, and consequent in *ability to clench the teeth on that side, and the devia* tion of the lower jaw to the affected side Moreover, in jection of relatively large amounts of local anesthetic or neurolytic solution within the mandibular nerve may cause spread along the perineural spaces but within the epineurium with consequent central spread to affect the gasserian ganglion In fact this is one of the technics of gasserian ganglion block For this reason, when carrying out mandibular block, it is essential to limit the amount of the solution to 1 ml

Mandibular nerve block is indicated in the manage ment of trigeminal neuralgia and other painful conditions limited to the lower jaw and the anterior two thirds of the tongue Injection of alcohol into the mandibular nerve results in a block which lasts an average of 18 months In treating cancer pain, it is frequently necessary to combine mandibular nerve block with block of the maxillary and, even more fre quently, with the block of the 2nd and 3rd cervical nerves In other instances the lesion spreads back to involve structures supplied by the 9th cranial nerve so that glossopharyngeal nerve block is also required to completely control pain

Mandibular nerve block at the base of the skull is a useful diagnostic and prognostic procedure in man aging the *Marcus Gunn phenomenon* This condition

follows injury of the oculomotor nerve and is characterized by abnormal upward retraction of the upper eyelid during mastication (95) It has been suggested that movement of the muscles of mastication initiates afferent stimuli which are propagated over the proprioceptive fibers of the mandibular nerve to the mesencephalic nucleus Here they initiate efferent discharges which pass via parasympathetic fibers associated with the oculomotor nerve and effect release of acetylcholine, resulting in marked contraction of the eyelids Block of the mandibular nerve (including the motor root), with a local anesthetic drug and subsequently with alcohol, can be employed to stop the associated movements In some instances, intracranial section of the 3rd division has been carried out in order to relieve permanently the jaw winking" phenomenon after indication by prognostic blocks that such interruption would be beneficial

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characterized by pain in the gland associated with reflex vasodilatation and sweating in the region of the temple and cheek during mastication Block of the auriculotemporal nerve interrupts the reflex and temporarily relieves the symptoms

Mental Nerve Block

Block of the mental branch of the mandibular nerve has the same clinical application as infraorbital nerve block (Fig 44) It is especially useful in the management of trigeminal neuralgia and herpetic pain limited to the lower lip and of neuralgia due to osteitis, as occurs in syphilitic disease of the bone Injection of 0 25 to 0 5 ml of alcohol usually produces prolonged relief *This procedure is rarely indicated for relieving* cancer pain since lesions of the lower lip are usually painless

Lingual Nerve Block

The pain consequent to carcinoma of the tongue may be controlled with lingual or mandibular nerve block, but if the malignant disease involves the base of the tongue, tonsils, and throat, the glossopharyngeal nerve must also be injected In some cases the floor of the mouth and the neck are also involved and require paravertebral injection of the 2nd and 3rd cervical nerves If the tumor involves the lower pharynx and larynx, superior laryngeal nerve block must be effected to relieve the pain Pain involving the middle and external ear is difficult to control since this structure is supplied by many nerves — the 5th, 7th, 9th and 10th cranial and the upper two cervical spinal nerves

BLOCK OF THE FACIAL (7th CRANIAL) NERVE

Block of the 7th (cranial) nerve has a very limited usefulness because at the stylomastoid foramen where the nerve is accessible to the nerve block needle it is purely motor It may be used as a diagnostic and rarely as a therapeutic measure in the management of facial spasm and painful tic convulsif Since the facial paralysis which results following the block is to some patients worse than the spasm and pain, it is important to repeat the block with local anesthetic drugs several times on different days before any consideration is given to the use of neurolytic agents In patients who have these conditions to an extreme and very disagreeable degree alcohol should be injected only as a last resort

Painful *tic convulsif* also known as *tic spasmodique* is characterized by periodic spasmodic contractures of the facial muscles of expression, accompanied by severe pain Though its cause is unknown, this condition in some way involves the motor and sensory components of the facial nerve Blocks may likewise be employed as diagnostic-prognostic measures Alcohol block may be used with caution in very severe cases

There are two very rare painful conditions which involve the small sensory component of the facial nerve, the so-called nervus intermedius, or pars intermedia of Wrisberg idiopathic geniculate neuralgia and Ramsey Hunt syndrome *Primary geniculate neuralgia* is characterized by paroxysmal, lancinating pain in the ear and is supposedly due to the same etiology as tic douloureux of the trigeminal nerve The so-called *Ramsey Hunt syndrome* or herpes zoster oticus is characterized by tic like pain in and behind the ear and by herpetic vesicular eruptions on the tympanum, ex-

ternal auditory meatus, lateral surface of the pinna, and the cleft between the auricle and mastoid process Since the sensory portion of the facial nerve is not accessible to the nerve block needle, this method can not be employed as either a diagnostic or therapeutic measure in managing either of these conditions

Some patients with facial nerve paralysis have pain which is usually experienced in and behind the ear and deep in the face The pain, which is of a deep, aching quality with a burning component, may precede the paralysis or may occur shortly after it is established Some writers have reported temporary relief following injection of the nerve with local anesthetic drug and *permanent relief following a nerve section* while others have treated this condition with cervico thoracic sympathetic block In passing, it should be mentioned that a number of other writers have reported good results with cervico thoracic sympathetic block in the treatment of nonpainful facial nerve paralysis

BLOCK OF THE GLOSSOPHARYNGEAL NERVE

Block of the glossopharyngeal nerve is useful as a diagnostic prognostic measure in the management of glossopharyngeal neuralgia a rather uncommon condition characterized by sudden, severe, lancinating pain in the throat with radiation to the angle of the jaw and occasionally to the ear and the thyroid cartilage The pain is brought on by swallowing, coughing, clearing of the throat, *yawning or sudden rotation of the* head Swallowing may be so distressing that the patient abstains from eating solid foods As a consequence, many of the patients frequently are dehydrated, malnourished, and cachectic Trigger areas are

often found in the tonsils, pharynx, or back of the tongue

Diagnosis may be confirmed by topical anesthesia of the throat, a procedure which should relieve the patient completely In some atypical cases, however, the vagus nerve is also involved, and it then becomes necessary to do a diagnostic prognostic anesthetic block at the base of the skull just below the jugular foramen This procedure will completely relieve glossopharyngeal neuralgia that involves the vagus nerve, even in cases in which topical anesthesia of the pharynx is ineffective Alcohol block of the nerve carries the danger of involving the vagus, hypoglossal, and spinal accessory nerves, and even more, that of destroying the wall of one of the large vessels, — internal jugular vein or carotid artery For this reason and because alcohol nerve block rarely produces a cure, it is best to treat this condition with intracranial section of the glossopharyngeal nerve

Rarely alcohol block is indicated in the management of glossopharyngeal neuralgia in patients in extremely poor physical condition The writer has used this treatment in a patient with bilateral pulmonary tuberculosis who developed the neuralgia during her stay in the sanitorium

Block of the glossopharyngeal nerve may be useful in treating cancer pain of the throat It is frequently necessary to combine it with block of the 3rd and/or 2nd division of the trigeminal nerve and frequently with paravertebral block of the upper cervical nerves Since the procedure produces paralysis of the pharyngeal muscle, a bilateral block is contraindicated except in very extreme cases in which the condition cannot be managed with any other measure

Carotid Sinus Block

Block of the glossopharyngeal nerve or the carotid sinus branch is useful in the management of carotid sinus syndromes The condition, as is well known, is characterized by recurrent attacks of syncope and is due to an abnormally sensitive carotid sinus reflex Block of the carotid sinus plexus is a very valuable diagnostic procedure to differentiate the three types of conditions, as well as to predict the effects of surgical denervation for treatment Block mav also be indicated prior to manipulation of the head and neck in patients with a sensitive carotid sinus

Block of the glossopharyngeal nerve may also be indicated in the management of carotid sinus reflex with neuralgia This is, indeed a rare condition characterized by symptomatology of the carotid sinus syndrome, but also accompanied by glossopharyngeal neuralgia The condition is frequently provoked by pressure on the neck over the region of the carotid sinus Frequently, the attack is preceded by sudden severe, burning pain in the throat and posterior part of the tongue and ear Some patients experience severe, lancinating pain then lose consciousness and go into clonic convulsions because of the marked hypotension etc Occasionally, it may be necessary to do repeated blocks of the glossopharyngeal nerves in order to improve the physical condition of the patients who are dehydrated and starving because of the inability to swallow

Cases have been reported of patients who had both glossopharyngeal and trigeminal neuralgia, requiring diagnostic blocks of one or both of these structures Such patients should be subjected to intracranial section of the roots of both nerves for cure

BLOCK OF THE VAGUS NERVE AND ITS BRANCHES

Block of the vagus nerve and its branches may be indicated in the management of various pain syndromes of the pharynx, larynx and tracheobronchial tree If the pain is localized in the larynx, superior laryngeal nerve block affords complete analgesia with-

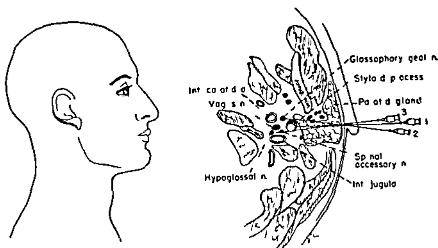


FIGURE 45 Technic of *blocking the glossopharyngeal and vagus nerves* Figure on the left shows the site where the skin wheal is formed approximately midway between the posterior border of the mandible and tip of the mastoid process The needle is inserted perpendicular to the skin and advanced until its point impinges on the styloid process as depicted by needle 1 in the cross sectional diagram on the right The needle is then withdrawn and redirected so that it will pass anterior to the styloid process and slightly deeper until its point is in contact with the glossopharyngeal nerve (needle 2) The vagus nerve is blocked by passing the needle posterior to the styloid process and advancing it about 1 cm deeper than the bone (needle 3) Injection of 3 to 5 ml of solution is sufficient

out the disadvantages of complete vagus nerve block This branch is the most commonly involved in idiopathic major neuralgia, which, like other similar syndromes, is characterized by paroxysmal, severe, unilateral, lancinating pain, radiating from the side of the thyroid cartilage or the piriform sinus to the angle of the jaw and occasionally to the ear Blocks of the vagus may be employed as diagnostic-prognostic procedures

Involvement of the branch to the ear usually requires division of the upper rootlets of the vagus nerve for cure Occasionally, a very clear-cut case of superior laryngeal neuralgia occurs in which the entire syndrome is localized in a small region over the thyrohyoid membrane on the affected side The attacks are precipitated by talking, swallowing, coughing, yawning, or stimulation of the nerve at its point of entrance to the larynx A differential diagnosis can be facilitated by blocking the superior laryngeal nerve or by combining topical anesthesia of the pharynx with jugular foramen block For definitive management, alcohol block of the superior laryngeal nerve is very effective

Superior laryngeal nerve block first with local anesthetic and subsequently with alcohol can be carried out in the management of patients with cancer and tuberculosis Frequently, it may be necessary to combine block of the pharyngeal nerve with paravertebral block of the 2nd and 3rd cervical nerves When the pain recurs, the procedure may be repeated, although some neurosurgeons prefer operative excision of a portion of the nerve

BLOCK OF THE SPINAL ACCESSORY (11th CRANIAL) NERVE

Block of the spinal accessory nerve is rarely indicated, but may be used in the management of severe tonic or clonic spasm of the trapezius and sternocleido mastoid muscles Since this nerve is purely motor, it is not usually involved in pain syndromes The procedure should be carried out with a long lasting local anesthetic drug such as Pontocaine or Nupercaine For obvious reasons, alcohol should be avoided

BLOCK OF THE HYPOGLOSSAL (12th CRANIAL) NERVE

Block of the hypoglossal nerve is also rarely indicated for the reason mentioned in the preceding paragraph In patients who develop severe spasm of the tongue, it may be necessary to block the nerve repeatedly with long lasting drugs The block may be indicated also in the management of certain autonomic disorders

TABLE VIII

SUMMARY OF TECHNICS OF CRANIAL NERVE BLOCK

Technic	*Usual Site of Injection*	*Approximate Volume of Solution (in ml or cc)*
1 Trigeminal	Meckels Cave Gasserian ganglion	1 2
Maxillary	Pterygopalatine fossa	2 4
Mandibular	Below foramen ovale	2 4
Inferior Alveolar and Lingual	Retromolar trigone of mandible	3 5
Supraorbital and Frontal	Supraorbital ridge	2 4
Infraorbital	Infraobital foramen or canal	1 2
Mental	Mental foramen	1 2
2 Facial	Stylomastoid foramen	2 4
3 Glossopharyngeal and Vagus	Below jugular foramen	5 10
4 Superior Laryngeal	Hyothyroid membrane	5 10

out the disadvantages of complete vagus nerve block This branch is the most commonly involved in idiopathic major neuralgia, which, like other similar syndromes, is characterized by paroxysmal, severe, unilateral, lancinating pain, radiating from the side of the thyroid cartilage or the piriform sinus to the angle of the jaw and occasionally to the ear Blocks of the vagus may be employed as diagnostic prognostic procedures

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